THURSDAY, DECEMBER 15, 1870

PRACTICAL PHYSICS

THE Vicissitudes of Families of Words, and especially of scientific nomenclature, would require another Burke to write their changeful history. Take, for instance, the word *Philosophy*,—how odd its present distorted meaning as compared with its literal sense, and how curious its alliance with such terms as Natural, Experimental, Mechanical, Chemical, and the like. Then, again, take *Science*,—how strange its present opposition to *Learning*, and how remarkable the adoption of the word *History* in conjunction with *Natural!* Most surprising of all, however, is perhaps the opposition set up between the words *natural* and *physical;* which has gone to such length that Prof. Huxley, in his recent Address to the British Association, could properly and intelligibly employ such a phrase as "those phenomena of nature which we call physical."

In French, the equivalent term for Natural Philosophy, "philosophie naturelle," is still sometimes used, and in a sense, if not coincident with, yet kindred to, that of its English representative; in German, however, the similar term, "Natur-Philosophie," has assumed a totally different meaning, and the word "Philosophie" by itself is, if possible, still farther from the English *philosophy*. For the latter word, in its English meaning, there is no equivalent whatever in German; while the occurrence of such expressions in English as Philosophical Instruments, co-existent with Moral Philosophy, strikes the German ear and intellect as insular eccentricity. But the German terminology is also in this respect not free from oddities. Thus, while "Experimentalische Physik" and "Theoretische Physik" (or sometimes "Mathematische Physik") cover nearly, although not precisely, the ground occupied by Experimental Philosophy and Natural Philosophy (in the orthodox sense) respectively; the word "physikalisch" has assumed a meaning opposed not to Moral but to Chemical, and a distinction has grown up between "physisch" and "physikalisch," corresponding to that between the English terms Natural and Physical.

To the terms just mentioned, Prof. Kohlrausch has now added a new one, on the title-page of a recently published little work, entitled, "Praktische Physik."* He thereby designates a series of practical exercises designed originally for the students who frequent the so-called "Physikalische Prakticum" in the University of Göttingen, for the purpose of being initiated into the use of physical instruments and the execution of physical operations. A work of this nature has long been a desideratum; although it has had a kind of forerunner in Prof. Frick's well-known "Physikalische Technik," *i.e.* Technical (or Operative) Physics, and to be distinguished from "Technische Physik," which means Physical Technology, or the application of Physics to manufactures and arts. Prof. Frick's work, however, of which three editions have appeared, was intended rather as an instruction in the making of lecture experiments and in the handling of the required apparatus, replacing in so far the older works of Abbé Nollet* and Sigaud de la Fond;† while the present work of Prof. Kohlrausch is designed as an initiation into original experimental measurements and researches. It has long appeared to the present writer as a kind of double drawback, inherent to current lectures as well as text-books on philosophy, that while, in all instances, more time or space is devoted to the description of apparatus and practical processes than is necessary or useful for the common student, they are yet, in this very respect, insufficient for the intending physicist. Taking in hand the best kind of treatises on Physics, whether of an entirely elementary or a more ambitious character, it will be found that a preposterous amount of space is taken up by drawings of instruments which the general student will never have to handle in his life, and by explanations of the manner in which certain procedures, measurements, and so forth have been taken, which it is practically equally useless for him to know, and which as a means of educating the mind have no value, while they tend to make science repulsive. On the other hand, the most voluminous works cannot but be pronounced, in this very respect, as deficient, if the wants of the young physicist are taken into account. Special works, like those of Profs. Frick and Kohlrausch, go some way towards supplying this want; and it is to be hoped also that, by multiplying or extending their scope, they will prove not only of additional benefit to intending physicists, but also to ordinary students, by ridding the vulgar treatises, and eventually lecture courses, of much superfluous matter that acts as a serious incumbrance and impediment to the spread of *real* physical science.

Prof. Kohlrausch's little book, of scarcely more than one hundred pages, reproduces, or very nearly so, the practical *curriculum* familiar to those who, in former time, attended at Göttingen the exercises which Profs. Weber and Listing superintended there for many years. The subjects selected range over a considerable field, and include a variety of problems; but the work was not intended to be exhaustive. Common weighing, specific weights and densities, thermometry, magnetism and galvanism, and optical instruments, furnish the chief topics on which exercises are indicated. Of course, the work is not designed to be read by itself, but to serve as a manual of instruction in the practical execution of the several processes. Nor should it be thought that even practical work of the kind here indicated can serve as a training for future discoveries, any more than early verse exercises make any one a poet; it completes, and familiarises with, the knowledge of discovered truths, but does not teach the discovery of truth. Original research of high value can be made as little on the pattern or with shreds of old, as genuine poetry can be composed in imitation and with patches borrowed from the ancients. Scientific investigation is a work of inspiration, and if directed towards a new aim, requires also novel instruments and new procedures. Chemical operations proper possess, it is true, a considerable degree of uniformity, and are capable of methodical treatment and exposition; but physical processes and manipulations are multiform, numerous, and difficult to classify. This is the reason why physical laboratories are as yet few and far between, and none of them so systematically organised as the chemical laboratories; and that, while the workers in

* *Leitfaden der Praktischen Physik.* Von F. Kohlrausch. (Leipzig, 1870.)

* L'Art des Expériences. † Cabinet de Physique.

Chemistry surpass in numbers, they also outdo in individual productiveness, the workers in Physics. But since the institution of physical laboratories is nevertheless spreading, the very novelty of their existence makes the publication of books like that of Prof. Kohlrausch, proceeding from older establishments, a real boon to those called upon to superintend or take a share in the direction of the practical work of new ones; and it is only to be hoped that from other places of renown also, both in England and abroad, similar publications may also soon proceed.

C. K. AKIN

GALLOWAY'S QUALITATIVE ANALYSIS

Manual of Qualitative Analysis. By Robert Galloway, F.C.S. Fifth edition, xxi. and 415 pp. (London: John Churchill and Sons.)

OF the various manuals of Qualitative Analysis now in use, none is more deservedly popular than the work of Professor Galloway. Much of this success is doubtless due to the painstaking care with which the author has sought in successive editions to reduce the operations of Qualitative Analysis to a more methodical and systematic process. The present edition is in great part rewritten, and much new and original matter has been incorporated. More systematic methods for separating the alkaloids are given, together with many additional reactions for their individual discrimination. The processes for detecting the poisonous metals in presence of organic matters are also much improved. A description of Bunsen's neat and expeditious flame reactions is likewise a new feature in the book. The delicacy and certainty of these reactions ought undoubtedly to lead to their more general adoption in our laboratories; even if their application is found to be limited, the lesson in neatness and dexterity in working to be acquired in their performance would prove invaluable to the student.

One of the characteristics of this book is its thoroughness, and the very example of this quality will not be lost upon the beginner. As an illustration of what we mean, we give the following extract from the introductory remarks on the province and scope of qualitative analysis:

> The analyst, by means of re-agents, interrogates the substance to be analysed as to what are its component parts; the reactions are the language in which the answer is returned. The student has therefore to learn the mode of questioning the substance, and the language in which the answer will be conveyed; in other words, he has to learn, not only what general and special re-agents are to be employed, but the order in which they are to be applied, and also the reactions they produce with the bases and acid-radicals, before he can attempt to search for these bodies in substances. No amount of *reading or lecture-hearing* will furnish the student with this knowledge; he can only obtain it by making the experiments himself of the different bases and acid-radicals with the re-agents, and "*he must always reflect, before the addition of the re-agent, for what purpose he applies it, and what are the phenomena he intends to produce.*" And the conditions indispensable for the production of correct and decisive reactions must be carefully observed, for a half-knowledge in all departments of science is of little worth, but in chemical analysis it is worse than useless.

There must always be diversity of opinion respecting the best method of teaching Qualitative Analysis, or indeed of teaching any branch of practical science; since so much depends upon the qualifications and conscientiousness of the teacher. In the Preface to the present edition of his book, Professor Galloway makes some very pertinent observations respecting the advantages which the method he adopts possesses over that employed by Fresenius and in the Giessen Outlines. It is quite possible that by faithfully following the plan laid down by the German professor, the student may succeed in correctly determining a larger proportion of the mixtures given to him for analysis, and yet the amount of actual benefit which may accrue to him may be far less than if he were more frequently unsuccessful by working under a system which left more to his individual judgment and intelligence. We believe that the method of Fresenius, as an educational agent, is radically bad; its tendency is to make the learner degenerate into a mere analytical machine. Such a system (to employ the phraseology of Mr. Galloway), of simply *telling* this and *showing* that, may be most pernicious in its consequences. The chief object in teaching chemistry is thus too frequently missed; science so studied renders the student utterly incapable of correctly reasoning upon the knowledge he acquires, for merely to create a number of proficient analysts is not the primary end of the introduction of qualitative analysis into the *curriculum* of our schools and colleges. A perfect system, then, is that which, whilst employing the most satisfactory and expeditious analytical methods, yet allows sufficient latitude for the student to exercise and strengthen the powers of his originality, reason, and intelligence. Such a system Professor Galloway has attempted to frame, and we have no hesitation in asserting that in the hands of a conscientious student his book will lead to the result which he desires to obtain.

T. E. THORPE

WORKS IN NATURAL HISTORY

Works in Natural History, &c. By the Rev. F. O. Morris, B.A.

THIS is, in several respects, a very remarkable pamphlet. It shows us, to our great gratification, that the study of Natural History is, thanks to the labours of Mr. Morris, gradually finding its way into Royal Palaces and Baronial Halls, for we learn that Her Most Gracious Majesty the Queen has accepted the dedication of his "History of British Birds;" that his Excellency the Right Honourable the Earl of Carlisle, K.G., &c. &c., influenced probably by Her Majesty's example, has extended his patronage in a similar manner to the "Natural History of the Nests and Eggs of British Birds;" that his "British Butterflies" and "British Moths" are under the genial and aristocratic guardianship of the Honourable Mrs. Musgrave and the Right Hon. Lady Muncaster; that his "Anecdotes in Natural History," and "Records of Animal Sagacity and Character," are dedicated by permission to the Most Hon. the Marquis of Westminster, K.G. and the Hon. Anne Emma Cavendish; while His Grace the Archbishop of York stands sponsor to "The Difficulties of Darwinism." Surely even in the so-called Golden Age of English literature, no author could have had the good fortune to secure so many noble patrons.

Appended to the title of each of Mr. Morris's works are "Notices of the Press,' and in this department the compiler of the pamphlet would, we think, have acted more wisely and more in accordance with the dignity of

Science, if he had restricted himself to journals, reviews, &c., of acknowledged literary merit, or treating specially of Natural History. Who, with a grain of common sense, cares to know, or attaches a shade of value to, the scientific opinions of such periodicals as the *Doncaster Gazette*, the *York Herald*, the *Derbyshire Advertiser*, the *Yorkshire Gazette*, the *Worcester Journal*, the *Bromsgrove Messenger*, the *Yorkshire Post*, *Our Own Fireside*, the *Oriental Budget*, the *Threepenny Magazine*, the *Penny Post*, the *Rock*, or the *Record?* This kind of puffing (for we can find no other term to express our meaning plainly) is bad enough; but there is worse, far worse, to come. It surely cannot have been with the knowledge and concurrence of "The Rev. F. O. Morris, B.A., Rector of Nunburnholme, in this county, and Chaplain to his Grace the Duke of Cleveland," as he is designated in the *York Herald*, that a series of anonymous opinions on his "Difficulties of Darwinism"—many of them abounding in the most gross and fulsome flattery of himself, and in vulgar abuse of his opponents—have been appended to the more legitimate notices of that book. Lest we should be supposed to be using unnecessarily strong language, we shall quote a few of these precious criticisms:—

"Professor Huxley's letter to you is in his usual style—flippant and rude. Your reply is in every way admirable.—Professor ——."

"I have read your pamphlet, and do not see how it can be answered.— ——Esq. M.D., A.B."

"Prof. Huxley's impertinent letter *deserved* what it has *got*. You certainly have given him a castigation.—Rev. ——, Cantab."

"The papers here steer shy of your pamphlet. They are on the other side, and find it awkward to reply to. I am very glad to hear that you purpose meeting Huxley at Liverpool. He requires a man that can expose his shuffles, and turn his banter against himself.—Rev. ——, D.D."

"Glad to see you an opposer to Darwin's nonsense.— ——, Esq."

The last of these absurdities is apparently a round-robin printed in a straight line: "We agree with all you say most perfectly. We cannot imagine how it can be answered by the Darwinites." Then follow three dashes.

Mr. Morris is not merely a well-educated English gentleman, but a clergyman and chaplain to a duke; and we feel that we are doing him a service in giving him an opportunity of stating (1) whether these extracts are really taken from letters addressed to himself, or whether they are forgeries; and, (2) in the former case, of explaining how they found their way into print in this obnoxious form.

A geological friend of ours, while trying to make a short cut, trespassed on a railway line. He had not gone far before he was stopped, and told by a grim official to retrace his steps. Our friend, thinking that a little "soft sawder" might help him out of the difficulty, observed: "My good fellow, you are perfectly right, and are only doing your duty; but I am much mistaken, when I look at your kindly and good-natured face, if you are the sort of man to turn a harmless geologist a couple of miles out of his route." The heart of the guardian of the road was so far softened by this speech as to let our friend proceed rejoicing, but, as a parting shot, he observed:—"Well, sir, I *do* like a bit of butter, but I ain't partial to grease." Now, to apply this anecdote, we sadly fear that Mr. Morris is "partial to grease." Many clergymen indulge in this taste, and one who has associated so much as this distinguished naturalist has done with the *Dii Majores* is apt to grow unctuous. On the assumption that these extracts are genuine, we can fancy that he carried the parcel of letters in his coat-tail pocket when visiting his parishioners, and occasionally sat down to enjoy a bit of grease, or, in other words, to read one or two extracts, as a cheerful mental stimulant; that probably on one occasion, the stimulant was too much for him, and that he inadvertently left the packet "*sub tegmine fagi;*" and that an enemy (probably a rabid Dissenting minister of a low class) picked up the prize, at once saw its value as a weapon against the Church of England, and gave it up to the Elders of his congregation, on the condition that they should publish it. It was then probably placed in the hands of a literary gentleman—possibly the Editor of the *Threepenny Magazine* or the *Penny Post*—and thus, and thus only, the appearance of the pamphlet can, we think, be rationally accounted for.

OUR BOOK SHELF

Resources of the Southern Fields and Forests, Medical Economical, and Agricultural. By Francis Peyre Porcher, M.D. (Charleston: 1869.)

In this book we have very full accounts of the uses of the plants of the Southern States of America. The author freely acknowledges in his Preface (or, as it is here termed, "Preliminary,') that he has availed himself largely of numerous works on kindred subjects, most of which have been published in America. In the introduction a few practical instructions are given for collecting and drying medicinal products of the vegetable kingdom. The plants are arranged according to their natural orders, the vernacular names being placed first, followed by the scientific names, and the distribution of the plants in the States. No attempt is made either at a scientific or popular description of the plants themselves; so that the book is literally what it professes to be, without being made bulky with matter that can, if required, be found in floras or purely botanical works. The book, indeed, is written more with an eye to the exposition of the medicinal uses of the plants; but the "economical and agricultural" portion is by no means lightly treated. In short, the information is most varied, as will be seen from a few quotations. Here is a recipe for making blacking from elder-berries, certainly an application we never before heard of:—"Boil elder-berries well, mashing the pulpy matter; then strain through a colander, and bottle for use. The liquid sours somewhat by age, but retains its qualities. Another way is to simmer ripe elder-berries over a slow fire in an iron kettle for one hour and let the mass cool, and you will have good blacking." Under the head of White Beech (*Fagus sylvatica*, and *F. americana*) our author tells us "the leaves of the beech trees, collected in autumn in dry weather, form an admirable article for filling beds. The smell is grateful and wholesome, they do not harbour vermin, are very elastic, and may be replenished annually without cost." There is nothing new in this application of beech leaves; they are used in many parts of Europe for a similar purpose, and were at one time so employed in England. Evelyn speaks of them as affording "the best and easiest mattress in the world to lay under our quilts instead of straw;" and by way of recommendation says that "divers persons of quality in Dauphiny" use them. The above are examples of what may be called purely economical applications. We take a cruciferous plant, the Gold of Pleasure, or False Flax

(*Camelina sativa*) as a single example of agricultural produce. "The cultivation of this plant for the seed would repay the farmer; an abundance of chaff would be produced which would be of infinite service for horses or for manure. In a grazing country like England, where vast sums are annually expended for foreign oil-cake, the Gold of Pleasure will soon be found an excellent substitute under manufacture, and, consequently, a grower should find a good remuneration in cultivating the seed The oil-cake has been found highly nutritious in the fattening of sheep and oxen, as it contains a great portion of mucilage and nitrogenous matter, which combined are found very beneficial in developing fat and lean." The prospects of making this a most important agricultural plant are, we think, too brightly drawn, considering that it has not escaped the notice of English agriculturists. Nevertheless, a few words of this kind on different products might help to promote experiments on their culture and utility. The writer's aim throughout seems to be a general utilisation of vegetable productions, and he very ingeniously finds a variety of application for those of the Southern States. We do not hesitate to say that a few books of this description on the economic products of different parts of the globe, would make us much better acquainted with the true value of the vegetable kingdom than we are at present.

JOHN R. JACKSON

Adventures of a Young Naturalist. By Lucien Biart. Edited and adapted by Parker Gillmore. (London: S. Low, Son, and Marston, 1870.)

THIS is a narrative of travel in Mexico, intended especially for young people interested in Natural History. The party consists of a young lad the hero, his father, a Swiss naturalist who does all the moralising, a dog, and one of those half-bred Indians who know everything and can do everything, who are such a bore in most books of Western travel. Though written in a somewhat pedantic style, we have no doubt it will find many admirers among our adventure-loving young readers, the country described being one of unsurpassed beauty and interest. For our own part, we should decidedly object to being cross-examined in the following manner before being allowed to eat our breakfast. "Do you know the family of the animal we are going to have for breakfast?" asked Sumichrast. "Yes; it is a Rodent." "Well done; but how did you recognise it to be so?" "By the absence of canine teeth in its jaws, its large incisors, and its hind-legs being longer than its fore-legs." Especially if the lesson were given in such a confused style as this:—"The bird belongs to the family of Climbers, that is to say, to that order which have two toes in front of their claws and two behind, like your great friends the parrots." Still the young naturalist will find in the book much that is interesting and amusing; and the numerous illustrations and gorgeous binding will make it an acceptable present during the Christmas season.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his Correspondents. No notice is taken of anonymous communications.*]

Contribution to the Dioptrics of Vision

IN the course of some experiments in reference to vision under water, I have ascertained some facts which I do not remember to have seen mentioned by writers on optics, and which may perhaps interest your readers.

Every swimmer knows that, however clear the water may be, and however distinctly he may see from the bank the smallest particle of gravel or weed, the moment he plunges beneath the water all becomes obscure, and he can see the outline of nothing at the bottom or suspended in the water distinctly, but only blurred patches of various colours. In my first endeavours to find a remedy for this imperfect vision, I found two ways of restoring perfect sight. The one was to surround the eye with a watertight box, with a piece of plain glass in front. By this means, the eye being in the same condition as to receiving the rays of light through an aërial medium as when we are on land, perfect vision is retained beneath the water. The other was, allowing the eye to remain exposed to the water, to look through a glass lens whose proper focal distance in the air, I found, after numerous trials, to be half an inch. The first method is attended by the disadvantages that the glass soon becomes dim from the condensation of vapour, and it is difficult to make it fit so accurately as to exclude the water; the second is more convenient, as any optician can construct a pair of spectacles suitable for the water, and fitted with lenses of the required focal distance.

Fishes, cetaceous animals, and seals, see perfectly below the water, while man's vision, unassisted, is of the most imperfect character. The eyes of these marine animals differ from those of terrestrial vertebrates chiefly in this: the latter have a very convex cornea, with a large chamber containing aqueous humour and a double convex lens behind; whereas the former have a flat cornea, hardly any aqueous humour, and a spherical lens, lying, at least in fishes, close behind the transparent membrane which is their substitute for a cornea.

Now, as an optical instrument, the eye of terrestrial vertebrates—and let us take that of man for an illustration—consists of two lenses, one placed behind the other. The anterior lens is formed by the aqueous humour, its actual figure being a meniscus, one surface being convex the other concave, but both surfaces uniting if prolonged. According to Donders, the anterior radius of curvature, formed by the cornea, is 8mm., the posterior, formed by the front of the crystalline, being 10 mm. The posterior lens is the crystalline, a double convex lens, its posterior surface, according to the same authority, having a radius of 6 mm. only. The combination of meniscus and double convex lens is known to possess peculiar optical advantages. The vitreous humour cannot act as a convex lens, its form being that of the concavo-convex lens, whose property is to cause divergence of rays of light; but, as it lies in contact with the retina, it cannot even produce this effect. It acts, together with the aqueous humour, as a watery medium for the suspension of the crystalline.

What happens when the human eye is immersed in water? A transparent lens-shaped body will refract the light in converging rays, if it is much denser than the surrounding medium through which the rays of light reach it. A simple experiment will prove this. Take two watch-glasses with their concavities facing one another; fill the space between them with water; this will form in air, than which it is so much denser, a lens of power proportioned to the convexity, but in water it will not refract the light at all, being of the same density as the light-conducting medium. The aqueous humour of the eye being much denser than the air, acts as a lens in the atmosphere, but being of the same density as water, when the light is transmitted to it through water in contact with the eye, we at once lose the use of our anterior lens, and can see nothing distinctly; because the crystalline, which alone now acts as a lens, throws its focus, as we shall presently see, beyond the retina.

How, then, are we to recover perfect vision under water? Obviously, by supplying the loss of our anterior lens by another lens of equal power. The focal distance in the air of a water lens of the meniscus shape and the dimensions given above may be calculated; it is, in fact, two inches or thereabouts; but, as we have seen, it $= 0$ in water. But, as the refractive power of a lens diminishes in proportion as that of the medium through which it receives rays of light increases, we find that a glass lens when immersed in water has only one-fourth of the refractive power it possesses in air. So, in order to supply the loss of our anterior lens, we find we must use a glass lens of about half an inch focus, which, in water, has a focus of about two inches. I need scarcely say, that in the case of a double convex lens of dissimilar curves it makes a great difference as regards the refractive power whether the lens be wholly immersed in water or one or other of the convex surfaces only. But I need not dwell on this subject at present.

But it is a clumsy method to supply the loss of a lens of two inches focus by one of the high refracting power of half an inch. Besides, a glass lens of this power is so small that the lateral field of vision is of necessity very limited, and it has a further disadvantage that we can see nothing with it in the air. I therefore sought for a lens that should be free from these defects.

As the ocular lens whose place had to be supplied is formed

of water, and receives in the normal condition the rays of light through air, I thought I might make my subaqueous lens of the same media. A couple of watch-glasses, placed with their concavities towards one another, so as to enclose a convex lenticular portion of air, when immersed in water, disperse the rays of light and diminish the size of objects seen through them, because they force the more refractive medium, the water, to assume a *concave* shape in relation to the air between the glasses. The same watch-glasses placed with their convex surfaces towards one another, and connected round their edges by a water-tight rim, thus enclosing a concave lenticular portion of air, when immersed in water, refract the rays of light convergently to a focus and magnify objects, because they force the more refractive medium to assume a *convex* shape in relation to the air between the glasses. Their magnifying power or focal distance under water is somewhat less than that of the same glasses in the reversed position and filled with water is in air; the slight difference being owing to the greater refractive power of the glass in air than in water. I found that two glasses of a curvature of about $1\frac{1}{4}$ inch radius thus placed formed in water a lens having a focus of about two inches. This *air-lens*, as it may be called, completely supplies the loss of our anterior lens in water, and restores perfect vision. Of course the same magnifying power may be obtained by various combinations of differently curved glasses, or by plano-concave or concavo-convex air-lenses. The advantages of this kind of lens for subaqueous vision over a glass lens are obvious. It can be made of any required size so as to command a large lateral field of vision. It ceases to act as a lens the instant it emerges from the water, and does not interfere with vision in the air, as then we merely look through two thin pieces of glass with some air between them. There is no provoking loss of refractive power, as in the case of the glass lens; and lastly, it can be made very cheaply. With either form of lens we can see from below the water objects in the air above us quite distinctly if the surface of the water is smooth, less distinctly if it is agitated.

Air lenses constructed on the principle described may be made of any magnifying power, and are much better adapted for the microscopic examination of objects under water than glass lenses, whose refracting and magnifying power is reduced to one-fourth by immersion. Thus a glass lens of a quarter-inch focus in air, would scarcely be equal in water to an air lens of one inch focus.

I have said that the difference between the refractive power of a glass lens in air and water is as 4 to 1, or even more. The difference is about the same in the case of the crystalline. Thus, the spherical lens of a cod, which has a focus of about $\frac{3}{20}$ of an inch in air, has a focus of about $\frac{3}{5}$ of an inch in water, which is about the distance of its posterior surface from the retina in the fish. Supposing the focal distance of the human crystalline to be, in air, $\frac{1}{6}$ of an inch, it will be more than $\frac{2}{3}$ of an inch in the fluid in which it floats. But, in front of it, we find what I have called the anterior lens—I mean the aqueous humour—with a focus, as I have proved, of about 2 inches. If we take two lenses respectively of 2 inches and $\frac{2}{3}$ of an inch focus, and place the weaker over the stronger, we shall find their united focal distance to be about $\frac{1}{2}$ an inch, or about the distance between the back of the human crystalline and the retina. My measurements, in the absence of appropriate instruments, lay no claim to exactness; they are, however, a sufficient approximation to truth for my present purpose.

How is it that after the operation of extraction of the crystalline lens, which has a focus of less than 1 inch in its natural position, the patient can see distinctly with a lens of from 3 to 4 inches focus? The reason seems to be that the optical character of the eye is completely altered by the operation. The space formerly occupied by the crystalline is now filled with aqueous and vitreous humour, and the eye represents a sphere of water, bulging in front into a more convex form by means of the cornea, which will have the effect of a superimposed meniscus of about 2 or $2\frac{1}{2}$ inches focus. A thin glass sphere filled with water of 1 inch diameter will roughly represent the eye deprived of its crystalline. We find the focus of this sphere to be about $\frac{1}{4}$ an inch. Let us place in front of it a lens of $2\frac{1}{2}$ inches focus to represent the bulging cornea, and we find the focal distance diminished by more than one-half. Another lens of 3 to 4 inches focus will bring this focus close to the posterior surface of the sphere, in fact, to the situation of the retina in the actual eye. This explains what happens in the eye deprived of its crystalline. Such an eye will require a much more powerful lens for subaqueous vision than that above described.

Montagu Square R. E. DUDGEON, M.D.

Dr. Lankester and the Scarlet Fever Epidemic

PERMIT me to make a few remarks on some notices of my paper on scarlet fever, published in your pages on the 17th of November last. Referring to my recommendation as to the destruction of the poison of scarlet fever, the *Pall Mall Gazette* says—"All this is very well in its way, and may be carried out by the upper and middle classes, among whom the mortality from scarlet fever is comparatively small; but the plan is quite out of the reach of poor creatures who have but one room, one bed, and one suit of clothing, which even at night takes the place of blankets." My object in writing the paper was to show that scarlet fever might be averted by certain measures, and I left it to those who read it to devise the means of making them available for all. When the cattle disease broke out, an Act of Parliament was passed for the purpose of diverting it. The lives of human beings are surely of not less value even in a money point of view than those of cows and oxen, and I have the conviction that certain measures might be adopted by the Government that would reach even the "poor creatures" to whom the *Pall Mall Gazette* alludes. Even now there exist Acts of Parliament which, if at once put in force by boards of guardians, town councils, vestries, and other local authorities, would at once enable them to put down this disease. The inhabitants in "one room, one bed, and one suit of clothing," are reached by medical men, and they might be empowered to remove the sick from the healthy, to destroy useless infected clothing, to have the infected linen washed, and generally to see that the disease is arrested. What can be done amongst the rich ought to be done amongst the poor, and expense ought not to be allowed to stand in the way of such merciful measures. It should be remembered that such outlay on the part of wealthy ratepayers would, in the end, repay them, as they catch this disease from its being fomented among the poor, and they would no longer be liable to these attacks when their less opulent neighbours were free from them.

In the pages of the *Lancet* "A General Practitioner" states that I have reflected on the members of the medical profession in stating that they do not exert themselves to suppress this disease. I spoke from a rather extensive experience on this subject, and regret to say that I have nothing to withdraw on this point. I did not say it was the fault of medical men. I said they were not instructed. This is the fault of a system of medical education in which public health is not contemplated as a part of its course It is true that within the last two or three years chairs of Hygiene have been established at University and King's Colleges, London, but these are exceptional. So deficient is the education of medical men on this very point, that the Government felt itself justified in opening a special medical school at Netley for the purpose of supplementing the defects of our ordinary medical schools. It is from the Chair of Hygiene at the Military Hospital that the most admirable work on Hygiene in our language, by Dr. Parks, has issued.

"A General Practitioner" could not suppose that I was ignorant of the fact that all that has been done for our knowledge of the nature of contagious diseases had been done by medical men, and that our medical officers of health have especially exerted themselves in endeavouring to prevent the spread of contagion. I must, however, again express my surprise at the small amount of information that can be gained from the text-books on the practice of medicine as to how best to prevent the spread of contagious diseases.

I will not in your pages do more than allude to the offensive tone and expressions of "A General Practitioner," but I may add that no amount of "support" I may have had or may expect to derive from members of my profession, will ever induce me to refrain from speaking the truth of them in the interests of the public. I am, however, fully convinced that it is only by such a course that I can hope to retain the respect and continued "support" of the more intelligent and honourable members of my profession. EDWIN LANKESTER

Professor Tait on Bain's Logic

IN your last week's number, Prof. Tait publishes a portion of his Introductory Lecture to his class, in which he criticises certain passages in my work on Logic, having reference to the doctrine of the Conservation of Force. Although I do not, in every instance, admit the justice of the strong condemnatory phrases used in the criticism, I am aware of having committed

a mistake in stating the relation of Momentum to Energy or *vis viva*, and will endeavour to rectify it.

In quoting a dictum of the late Dr. Boole, Prof. Tait styles him the greatest logician the world has produced, or is likely to produce, for many a long day. In dissenting from this superlative, I do not refer to the men most widely known in recent years as logicians—Whately, Hamilton, Mill, Mansel; I consider that the comparison of them with Boole fails through the dissimilarity of the matters compared; his Logic was but to a very small extent the Logic of any one of these writers. The only person who cultivated Logic in the manner of Boole was another noted mathematician, the veteran De Morgan. Now, without undertaking to say which of these two had the greater genius, I do not scruple to affirm that the labours of De Morgan, in their common department, if only through longer continuance in time, resulted in a much larger number of contributions to the science than can be credited to Boole. The two men were friendly co-operators, not rivals; and they will, I have no doubt, be mentioned together as often as reference is made to the Algebraic extensions of Formal Logic.

Aberdeen, Dec. 9 A. BAIN

The Spectrum of the Aurora

THE brilliant displays of the Aurora Borealis observed in England on the 24th of September and the 14th of October, 1870,* were also generally observed in this country. The fact may be worthy of record in your journal, as indicating the unusual extent of the phenomena. As the newspapers in different parts of the United States contained full descriptions of these displays, a detailed account need not here be given. I may remark, however, that they were generally regarded as the most brilliant displays we have had since 1859. Fine auroras were again witnessed on Monday morning, October 24th, from 5 to 6.30 A.M., and on the evening of the same day, from 6 to 11 P.M. At 9 P.M. (on the evening of the 24th) an auroral arch passed very nearly through the zenith from the eastern to the western horizon, or rather from a point a few degrees south of east, to another somewhat north of west. An extraordinary number of more feeble auroras have been noticed during the last two months. DANIEL KIRKWOOD

Bloomington, Indiana, Nov. 9

Can Aurora be Seen in Daylight?

I VENTURE to believe *not*, in spite of circumstantial accounts to the contrary, and I ground my belief on the following considerations:—1. No description of a daylight aurora that I have ever seen will bear a critical examination. Take that published in the last number of NATURE. Here two arcs of faint white lines are said to have been seen in a direction "almost due east," and certainly the illustration given is not very unlike the appearance that auroral arcs sometimes present. But auroral arcs, so far as I know, never appear in the east, and the conclusion, therefore, is unavoidable that the object observed was nothing more than a remarkably symmetrical form of cirrus cloud. In another instance, lately published, although the thing described is called a daylight aurora, I fail to see in the description anything more than an account of the appearances presented when a high canopy of cloud clears off bodily from the sky with a sharp, straight edge, which by perspective becomes an arch. In the case referred to, the clouds clearing off from the direction of magnetic north, the arch corresponded in position with that of an aurora, and hence was set down as auroral. In a third account of a daylight aurora, it is expressly mentioned that the sky was hazy, and a solar halo visible, a condition of things which, while it would make the occurrence of aurora-like cirrus extremely probable, would be specially unfavourable to the visibility of a true aurora; for certainly if so delicate and phosphorescent a light as that of an aurora is to be seen at all in the daytime, it can only be under circumstances the most favourable as regards clearness of the lower atmosphere.

2. A comparison of the auroral light with the light of other objects whose visibility can be more easily measured, tends strongly to confirm the view I have advanced. No one who remembers Donati's comet at its brightest will hesitate to allow that for intrinsic brilliancy that object surpassed the most vivid aurora. Yet Donati's comet at its brightest could not be detected with the naked eye until about half an hour after sunset, and then only the head could be seen.

3. The modifications of cirrus cloud are so infinitely diversified, and sometimes so very remarkable, as to offer a great temptation to the observer to invest them with the mysterious attributes of the aurora. Moreover, they do occasionally present a very striking resemblance to pencils of auroral light, differing, however, essentially in the character of fixity which they possess, as well as in the absence of any determinate relation to the magnetic pole or zenith.

On the grounds now stated I venture to refer daylight auroras in general to the large class of "errors of observation."

Clifton, Dec. 13 GEORGE F. BURDER, M.D.

* NATURE, Nos. 49, 50, and 51.

The North London Naturalists' Club

THE Secretary of the North London Naturalists' Club desires the Editor of NATURE to correct an incorrect statement which appeared in the last number of that journal. The North London Naturalists' Club is not broken up, it is not six years old, nor has it ever met on a Monday. Its last meeting was on Thursday, Nov. 24, at Myddelton Hall. Three subjects were then exhibited and explained, viz. "The Structure and Growth of the Yeast Plant," "The Structure of the Gastric Teeth in the Lobster," and "The Anatomy of Amphioxus." The meeting was thinly attended, but that is no alarming phenomenon for societies of this kind. The previous meeting on Oct. 27 was a very full one, owing to a paper read by a deservedly well-known member of the club on the highly interesting subject of "Spontaneous Generation." It must be confessed that the club is not so vigorous as when first started, but these facts show that it is by no means defunct. J. SLADE,

Hon. Sec. N.L.N.C.

Browning's Spectroscope

IN the last number of NATURE there is a description by Prof. Young of a spectroscope, in which the prisms are made to alter their positions relatively to each other by bending backwards and forwards the metal work to which they are attached. I should of course not wish to offer any opinion on the efficiency or otherwise of this arrangement.

My reason for writing is that in the course of the article Prof. Young goes out of his way to remark that, in attaching bars at right angles to the bases of the prisms in my Automatic Spectroscope, I have adopted a plan of Mr. Rutherford's. Will you kindly permit me to state that I began my Automatic Spectroscope in the year 1862, and that, so far as publication consists in exhibiting anything to a large number of persons, I had published it in the year 1863. I have reason to believe that M. Duboscq also attached bars in a similar manner to the bases of prisms with the intention of obtaining a minimum deviation adjustment, about the same time as myself, or soon afterwards. I do not know at what time Mr. Rutherford may have contrived his plan, but, as I have never read any description of his instrument, I must disavow having adopted any plan of his. At the same time I must remark that it is a small step towards obtaining the complicated movement required to produce an *automatic* minimum deviation adjustment, and it seems to me that it is a step every person would be likely to take who wished to obtain the adjustment by a mechanical motion.

111, Minories, Dec. 12 JOHN BROWNING

Evolution of Light

YOUR correspondent, who describes in the number of NATURE of the 17th ult. a faint light observed by him on tearing strips from a woven fabric in the dark, may be interested to know that a similar phenomenon is noticed by Mr. Grove in his "Correlation of Physical Forces," as occurring with indiarubber waterproof cloth (4th ed. p. 48).

Mr. Grove ranks it under phenomena of heat and light, rather than of electricity. C. J. T.

Fungi

IT is very unfair that the mushroom family should lie under a ban, because Locusta, at the instigation of Agrippina, employed

some kind as a medium for conveying poison into the stomach of Claudius. With equal justice the mild Calenian wine would have been in ill repute because poison was not unfrequently mixed with it—

> Occurrit matrona potens, quæ molle Calenum
> Porrectura viro miscet sitiente rubetam.

I cannot therefore think that the bad name clinging to the whole family of agarics was thus incurred; for Locusta did not employ a poisonous fungus for her deadly purpose: she mixed poison with some kind of mushroom of which Claudius was particularly fond, and of which he had no doubt often partaken. The words of Tacitus are explicit; he says that "the writers of those times have related that poison was poured into a dish of *boleti*, of which the Emperor was fond;" "Temporum illorum scriptores prodiderint infusum delectabili cibo boletorum venenum." (An. xii. 66.) Suetonius is equally clear: "Boletos in quo cibi genere venenum acceperat." (Nero 33.) Pliny, too, seems to regard the boleti, which he calls an excellent food, as the vehicle conveying the poison: "Veneno Tiberio Claudio principi per hanc occasionem a conjuge Agrippina dato." (Nat. Hist. xxii. 22.) Cases of accidental poisoning by fungi no doubt occasionally happened amongst the ancients as amongst ourselves, but I doubt whether any of the family of fungi were ever designedly employed as a poison. According to Pliny, Annæus Serenus, the prefect of Nero's guard, with his tribunes and centurions, accidentally met their death by eating some poisonous fungus; I am not aware that any other writer records the circumstance; it is rather curious that Seneca, a very dear and intimate friend of Serenus, makes no allusion to the cause of his friend's death, in his touching lament over it, when we remember the philosopher's intense aversion to the fungus tribe. Here is a specimen of his vigorous diatribe: "Good gods! how many men does one belly engage! What! Do you think that those boleti—a pleasant poison—albeit they hurt not now, conceal within them no hidden mischief?" (Ep. xcv.) In another place (Ep. cviii.) he speaks of boleti and oysters together as things he had for ever renounced: "For they are not food, they serve only to tickle the appetite, constraining those that are full to eat more; a very gratifying amusement to such persons as stuff themselves with such things as readily go down, and as readily return." The *boletus* instrumental in causing Claudius's death has been supposed to be the *Amanita cæsarea*, the specific name being given to this fungus on that account, but the point cannot be decided. That the genus *Amanita* was known to Pliny appears pretty evident from his description: it is first covered by a volva, egg-like, and then it breaks through this and rises on its stem. I can find no distinctive mention of the tubes or pores, characteristic of the order Polyporei, in any classical author. The *boletus* of the ancients might have included the modern genus Boletus and some of the Agaricini. Some of the Polyporei are no doubt denoted by the *μύκητες ἀπὸ τῶν ῥιζῶν καὶ παρὰ τὰς ῥίζας φυόμενοι* of Theophrastus (iii. 7, § 6); and Pliny probably means the same when he speaks of fungi growing on trees. Whatever the boleti were, they were highly esteemed; we find them not unfrequently contrasted with *fungi* and *suilli*:—

> Vilibus ancipites fungi ponentur amicis,
> Boletus domino. (Juv. *Sat.* v. 146.)

Compare also Martial (iii. 60):

> Sunt tibi boleti; fungos ego sumo suillos.

Boleti were so good that you could not trust a slave to convey them to a friend; he would be sure to eat them on the way:—

> Argentum atque aurum facile est, lænamque togamque
> Mittere: boletos mittere difficile est. (xiii. 48.)

What the kind known as *suilli*, "hog-fungi," were, cannot be determined.

W. HOUGHTON

Hereditary Deformities

THE facts about hereditary epilepsy in guinea-pigs, mentioned in NATURE of 3rd ult., on page 14, appear to show that mutilations may be inherited when accompanied by functional derangements; though there appears to be very little, if any, evidence of mutilation being inherited when not so accompanied.

Dr. Carpenter says somewhere (I cannot find the reference) that small scars are sometimes more persistent than large ones. We might consequently expect that they would be liable to become hereditary. But this does not appear to be the fact. To mention an obvious instance: in many countries, the ears of all the girls, and of many of the boys, are pierced for earrings. We could not expect to find the perforation hereditary, but it would not be wonderful if the external scar were to be so; the smallness of the operation, not amounting to mutilation, and not producing any functional disturbance, might be thought to be in favour of this result. But I am not aware that it is ever found.

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim

The Colour of Feathers and of Butterflies' Wings

THE change of colour observed by E. V. F. (NATURE, No. 55) in the red parts of the wing of a butterfly by the application of muriatic acid, is in all probability due to the red colouring containing a trace of copper in its composition. I have demonstrated the almost universal presence of that metal in the sea, in the earth, in fish, in flesh, in vegetables.

Not long ago Professor Church showed it to exist in the red feathers of birds.

SEPTIMUS PIESSE

Chiswick

Man's Bare Back

WILL you be good enough to favour me with a small space in your excellent journal for these few lines, in answer to Mr Wallace's difficulty with regard to the nudity of the back of man. According to Darwinian principles, there is what is called correlation of growth, by which I believe is meant, that an organ, or some part of the organism, is selected, not because itself is useful, but because its growth is somehow correlated to some other organ which is useful. Now, as a growth is admitted which exists by virtue of its correlation to some useful organ, why should not an atrophy of some part of the organism also be admitted as correlated to some organ which has been naturally selected on account of its usefulness? Although the nudity of the back of man is not in itself useful, nevertheless the atrophy of the hair on his back may be correlated to the development of some organ peculiar to man, and which is useful to him; or, in other words, the growth of the hair on the human back, although in itself useful, is incompatible with the growth of some other organ which may be infinitely more useful to him. Such atrophy, for all we know to the contrary, may be in some way correlated to cerebral development, to the erect posture, to the development of the hand, to the organs of speech, &c. At all events, if we cannot positively state that our dorsal nudity is so correlated, we certainly cannot say that it is not. I do not think that Mr. Wallace is justified in excluding the nudity of the back of man from the theory of natural selection, because he cannot show that it is useful. It may not in itself be useful, but it may be subordinate to some organ which is most useful. I consider that if the principles of a correlated atrophy be admitted, the stumblingblock of our bare backs will cease to trouble Darwinian thinkers. The argument struck me when I first read Mr. Wallace's remarkable "Contributions to Natural Selection," but as I now see, by his article in p. 9, No. 53, Vol. III. of NATURE, that his difficulty has not been answered, I venture to address the foregoing to you, with the hope that my argument may be of some utility.

E. BONAVIA, M.D.,
M.E.S. of London

Nov. 13

Loss of Temperature in Climbing

FREQUENT reference has been lately made to the thermometrical results obtained by Dr. Lortet while walking up Mont Blanc, in which, as stated by Dr. Corfield in NATURE of Dec. 1, his temperature fell about 4° C. in ascending nearly 4,000 metres. Mr. E. R. Lankester informs me that when undertaking the same journey, he also found his temperature much lower when he was up high than when he started.

At first sight this result is unexpected, but it was predicted long ago by Joule, who, in the appendix to a paper read at the British Association in 1843, states thus:—"If an animal were engaged in turning a piece of machinery, or in ascending a mountain, I apprehend that, in proportion to the muscular effort put forth for the purpose, a diminution of the heat evolved in the system by a given chemical action would be experienced."

This is evidently the key to the whole subject, and I hope shortly to publish other results, now in an incomplete form, which bear on the point.

It is evident that the potential energy which results from ascending a hil is gained by the expenditure of work, and a loss of heat from the body must naturally follow; while in walking on

level ground, the potential energy acquired when the foot is lifted, and the consequent slight loss of heat, is neutralised by the *internal* work necessary to prevent the foot having any actual energy at the moment it touches the ground.

Upon this theory it is clear that the fall of temperature must be greater as the height arrived at is more considerable; and that the body must soon regain its normal temperature when the experimenter ceases to ascend. Lortet's observations agree perfectly with these requirements, he finding that his temperature was normal in less than half an hour after he had reached the summit.

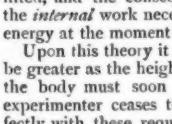
In descending a hill the temperature ought evidently to rise greatly if this explanation is the true one.

A. H. GARROD

St. John's College, Cambridge, December 3

Hailstones

I HAVE frequently observed that when hailstones are large and well formed, they are almost invariably round and smooth at one end, and roughly conical at the other (as in the annexed sketch), so as to suggest the idea that they are broken portions of spheres, of a structure radiating from the centre.



Perhaps some of your correspondents can inform me if there is any proposed theory which accounts for this peculiar form, which should throw some light on the formation of hail.

H. R. PROCTER

Clementhorpe, North Shields

ENCOURAGEMENT TO NATURAL SCIENCE AT TRINITY COLLEGE, DUBLIN

NOTICES have from time to time appeared in this journal of scholarships, exhibitions, &c., obtainable in various colleges at Oxford and Cambridge, for proficiency in the purely Natural Sciences. From these we see that the neglect with which the study of nature has been treated is gradually giving way, and that our great Universities are at last becoming alive to the importance of this branch of learning, and to the necessity for encouraging its pursuit among the students. It is a matter for surprise that no similar mention of rewards for Natural Science is ever made with respect to the University of Dublin. And yet, were a Fellow of Trinity College asked what was being done in this direction at his University? he would probably answer, "Oh, a great deal! there are gold and silver medals awarded at the Moderatorship Examination for Natural and Experimental Science; then there are four or five Science Scholarships given annually." It is true a student may take out his degree with honours in Natural Science, and receives a medal, but let us see what is the course for the so-called Science Scholarships; the subjects are mathematics, pure and applied, for which 350 marks are obtainable, and, as a secondary course, either logic or physics, for which fifty marks alone are given. Such are the rewards and inducements held out to the student of *Natural* Science. It is scarcely to be wondered at that the most promising men in the University do not go in for them, but devote themselves to the more profitable classics or mathematics. For these the rewards are liberal and numerous; there are no less than seventy foundation scholarships, and many others, besides a great number of exhibitions, of which, within the last few months, thirty in addition have been granted by the Board. Not one of these has the man who devotes himself to chemistry, zoology, botany—in short, to Natural Science—a chance of obtaining. We ask—is this fair? Even supposing it unadvisable to divert any of these scholarships or exhibitions from their accustomed channels, yet surely the Board might establish one or two additional ones out of the—confessed to—60,000*l.* annual income.

About a year ago it was rumoured that a "studentship" would in future be given at the degree examination to the first gold medallist in Natural Science, but the idea seems to have died a natural death, and those in whose bosoms a ray of hope had arisen have been doomed to disappointment. It is not to be supposed that the authorities of Trinity College, Dublin, are in any great degree adverse to changes. On the contrary, when a reform (?) is not especially needed, they are not unlikely to introduce it; thus, for instance, the harmless old custom of setting the college clock a quarter of an hour late—giving the students, as it were, a quarter of an hour's law—has been abolished, and the hour for "commons" has been altered.

But we have no wish to lead any one to imagine that an altogether bigoted and unchanging spirit pervades the University: we have much pleasure in saying that many of its institutions are truly liberal; and we can scarcely doubt that before long the governing body will look with more favour on the Natural Sciences, and that they will become aware that Ireland—not so very flourishing at present—will be anything but a loser when the National University sends forth a greater number of scientific men.

A.

THE CONSTRUCTION OF HEAVY ARTILLERY

II.

CHOICE OF MATERIAL

IN an article which appeared on the 24th of last month, we endeavoured to explain the construction of our large ordnance, and to trace briefly the steps by which the combined strength and simplicity of the present pattern in the British service—the Woolwich Gun, as invented by Mr. Fraser—were attained. Simplicity is one chief element of strength; the fewer pieces anything is made of in general the stronger it is, and it has also the advantage of cheapness; but simplicity is seldom the beginning, it is rather the end of a series of inventions and improvements, and this has been the case in gun manufacture.

Having traced the steps of the process, and glanced at the history of its development, one topic more remains to be treated in order to give completeness to the subject, and that is the choice of material; and although the choice of material must come first in actual construction, to know the manner in which the gun is formed, and the qualities sought to be developed in the construction, will be a great help in understanding what qualities it is desirable that the material should possess. There are two qualities between which the choice lies; these are *hardness* and *toughness*. The British Government has decided, we think wisely, in favour of the latter. Hardness is the proper quality to resist a statical force, or pressure; toughness to resist a dynamical force or blow, and the explosion of gunpowder is not only a dynamical force, but it is the greatest that we have to deal with in any mechanical problems. If a hard substance is subjected only to a blow which it is quite able to resist, whose strain is well within the limits of its elasticity, then it is a very fit and proper material for the purpose; and this was the case with the old smooth-bore guns, which were all cast-iron. They were quite strong enough to do with safety all that was required of them. But for the force now imparted to rifled projectiles with their immense range, their tremendous armour-piercing *vis viva*, cast-iron guns are altogether inadequate. Much lower charges than those of our wrought-iron rifled guns would burst them into fragments. Did nature supply us with a material so hard that the strain of gunpowder was easily overcome by it, it would do very well for all guns. If, for instance, diamonds existed of sufficient size that a piece of heavy artillery might be bored from one, then they would be a very admirable material for the purpose. But, as this is not the case, we must fall back on tough instead of hard substances, the more especially as it does not do to approach

the limit of resistance, for hard and crystalline substances have often flaws which no inspection can discover, and which only reveal themselves at the moment of destruction, and also such guns, when they burst, always do so explosively, without previous warning. This is not the case with tough material, which can yield through a very considerable extent before breaking. It may be objected that this could be overcome by increasing the thickness of cast-iron guns. But it is found that, after a limit very soon reached, increase of thickness does not produce increase of strength. The following law has been ascertained, that "no possible thickness can enable a cylinder to resist a pressure from within greater per square inch than the tensile strength of a square inch bar of the same material." That is—to take an example—if a cylinder of cast iron, whose breaking strain is ten tons per square inch be subjected to that amount of interior pressure, it will from the very first occasion begin to give way. At first, the inner surface would be ruptured, and the expanding gas or other source of pressure, taking advantage of the fissures, would quickly extend and complete the work of destruction. The inner portions of such a cylinder have much more work to do than those farther out, the same amount of force acting over a greater extent of surface or lamina. It may therefore be roughly estimated that the strains on the successive portions or rings vary inversely as the square of their radii. Dr. Hart, Fellow of Trinity College, Dublin, taking into account the compressibility of the metal, has given the following formula, $\frac{\sigma}{s} = \frac{r^2}{\rho^2} \cdot \frac{R^2 + \rho^2}{R^2 + r^2}$, where s is the strain on the inner surface, σ that on a ring of which ρ is radius, and R and r are external and internal radii of the cylinder. To compare the strains on the inside and outside, let S be the latter, and, as $\rho = R$, the formula becomes $\frac{S}{s} = \frac{2r^2}{R^2 + r^2}$. Applying this to the case of a gun of ten inches calibre, with a thickness of side of five inches, $r = 5$, $R = 10$, and S is to s as 50 to 125, so that more than twice as great a strain is borne by the inner surface as by the outer.

This brings us face to face with one of the great objections to cast-iron guns. In all castings the outer part, which cools first, is stronger than the interior. The metal contracts in cooling, and as the heat first leaves the exterior it first becomes solid, and the inner particles successively unite to it in layer after layer of crystals; so that the centre contains metal but imperfectly coherent. In a casting of two or three feet diameter, a central portion of six, eight, or even more inches in diameter, is found consisting of a spongy mass of scarcely coherent crystals of iron, sometimes with cavities visible to the eye when a section is made. This is exemplified in the annexed drawing (Fig. 1) of a 13-inch sea-mortar shown in section with the head of metal with which it is cast remaining attached, the parts to be cut off and bored out being marked by a black line. The shaded portions represent the weak and porous parts of the metal, which extend down through the centre below the bottom of the powder chamber, where it leaves a soft spot, easily hammered and burnt away by the shock and blaze of the discharge. It is plain that in any piece of artillery thus formed, the strength of the sides must gradually decrease from the exterior to the interior, which is precisely the reverse of what is required. To remedy this the Rodman cast-iron guns, used in the United States, are cast round a core or closed tube, which is inserted in the mould and represents the bore of the proposed gun. Into this tube a stream of cold water is kept continually pouring, so that the molten metal first solidifies round it; and, further, to secure this a fire is kept up round the mould for some time after the casting has begun. Here we have the conditions required in a cast-iron gun, viz. the best and strongest metal in the interior round the bore. Fig. 2 represents a 15-inch Rodman cast in this manner. It will be observed that in its shape, which resembles a soda-water bottle, all angles are avoided and a rounded form carefully preserved. By this another source of weakness is avoided, through compliance with an important law of nature. When any substance solidifies under the influence of heat leaving the mass, "the principal axes of the crystals will always be found arranged in lines perpendicular to the bounding planes of the mass, that is to say, in the lines of direction in which the wave of heat has passed outwards from the mass in the act of consolidation." (The Construction of Artillery, by R. Mallet, M.I.C.E., &c., &c. 1856.) This direction is that of least pressure within the mass, being that of the motion of the heat waves; and the law above stated is part of the far more general principle that in nature the line of least resistance is the one invariably chosen. From this law it follows that wherever there is an angle or sudden change in the form of a casting, through that angle there runs a plane of weakness, arising from irregular crystallization, as the crystals arrange themselves perpendicularly to the surfaces. Every abrupt change in the form of the exterior of a casting, every salient or re-entering angle, no matter how small, upon the exterior of a gun or mortar, is accompanied by one or more planes of weakness in the mass. This was strikingly exemplified in the cylinders of the hydraulic press made for raising the tubes of the Britannia Bridge. The first was made with a flat bottom, consequently it had planes of weakness as shown by the lines VV in Fig. 3, and under the enormous pressure to which it was subjected it gave way, the bottom curving out in the direction of those lines. The second cylinder was made with a rounded bottom, as in Fig. 4, and successfully resisted the pressure to which it was exposed. Cast-iron guns give evidence in bursting of planes of weakness in accordance with this law. The usual lines of fracture are shown in Fig. 5. Any visitor to Woolwich Arsenal can, by inspecting the cemetery where the guns burst in proof or for experimental purposes are preserved, verify this law of nature from many examples. By the form of the Rodman gun this source of weakness is avoided. It is a cast-iron gun, made on thoroughly scientific principles, in which the material is used to the utmost advantage, and therefore it may justly be compared with the Fraser gun, in which the same thing is done with wrought-iron, to measure the value of two materials. A casting is always cheap compared with a forging; in this point the Rodman has the advantage. But at its best, cast-iron has only one-third the strength of wrought-iron. Consequently the Rodman gun cannot be safely rifled. It fires heavy round shot, but with a range and accuracy greatly inferior to that of an elongated rifled projectile. Its initial velocity is high, but it is not long kept up. At close quarters its *racking effect* upon armour plate would be very severe, but its penetrative power is low. In the extensive experiments made at Shoeburyness in 1868 the 10-inch Fraser gun of 18 tons weight penetrated fifteen inches of iron (in three 5-inch armour plates), upon which the Rodman 15-inch gun of 20 tons only made a shallow indent. Further, being cast-iron, they are liable to burst explosively without any previous indication, and from the metal being in a state of great tension, being cooled from the inside, they have been known to break up in store.

The facts stated in the comparison of the best and most scientifically-constructed cast-iron with wrought, seem to be very decisive against the former. Two other materials have to be noticed. One is bronze, or gun-metal. It has some admirable qualities for making a gun. A bronze gun is hardly ever known to burst under ordinary circumstances. So great is its tenacity that with continued firing such a gun has been known to swell and change form without bursting.

But there are two objections to its use for heavy artillery that are decisive against it:—It is very expensive. The respective cost of guns of the several materials treated of in this paper may be taken in general as stated in the following table:—

Cast-iron guns . . .	£21	per ton weight of gun.
Armstrong wrought-iron	£100	" "
" " Fraser construction	£65	" "
Steel on Krupp's or Whitworth's plan .	£170	" "
Gun-metal	£190	" "

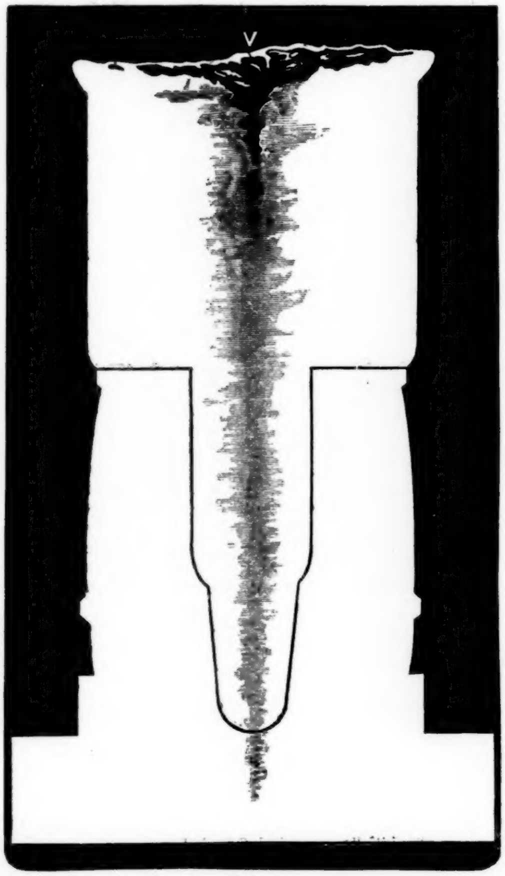


FIG. 1.

But a still more fatal objection to gun-metal for heavy pieces of artillery is its softness, and the rapidity with which it becomes heated. It is therefore quite unfit for the large charges of powder and immense rifled shot, with its severe friction on the bore, which are used in armour-piercing guns. Even small bronze guns, when fired repeatedly, exhibit the curious phenomenon of "drooping at the muzzle." This has been very interestingly explained by Mr. Mallet in the valuable work before referred to, and shown to arise chiefly from the rapidity with which that metal takes up heat. For large guns it is a material out of the question.

The last material to be spoken of is a far more formidable rival to wrought-iron, namely, steel. Of this Krupp's guns and Sir Joseph Whitworth's guns are constructed. The latter are made in a series of cylinders like the Armstrong coils, and which fit very tightly one over the other, and are forced on each other by hydraulic pressure. The former are bored out of huge solid ingots, which have been hammered to give them a fibrous character. Now steel has some admirable qualities as a material for heavy guns. It is very hard; and this makes it very suitable for the grooves of a rifled gun which have to bear such severe friction from the shot. For this reason all our wrought-iron guns are provided with an inner tube of steel. Moreover, it is very strong; the average breaking weight of a bar of steel of an inch sectional area is thirty-one tons, against twenty-five tons for a similar bar of wrought-iron (in the direction of its fibre) and ten tons for cast-iron; and when toughened by being tempered in oil the breaking weight rises as high as forty-five tons to the square inch. The reason why steel is so much stronger when tempered in oil instead of water, is, that the boiling point of oil is so high (600° F.) that it withdraws the heat very slowly from the red-hot mass plunged into it, compared with water, which is turned into vapour at 212° F. The steel for the tubes of the Woolwich guns is always thus tempered. But though steel has these admirable qualities as a material for heavy artillery, there are very grave objections to its use, and, on the whole, good reasons for preferring the wrought-iron guns to any steel ones that have yet been made. One is the greater cost, as shown in the table given above. A much stronger reason is, that though steel bears a gradual pressure so well, such as that of a testing machine for the breaking weight, it is brittle under a very severe dynamic strain or blow. When a steel gun bursts, it does so explosively without previous indications of yielding, and breaks up into fragments like a cast-iron gun. Another objection, and one perhaps even still more weighty, is that it is very difficult to make steel in large masses homogeneous throughout, and free from flaws. It is very much a chance whether it is so or not; and in the case of a gun, this is determined by the fact of its not bursting in service, but cannot be settled by a few proof shots beforehand. A good steel gun is a weapon of wonderful power and very great endurance. But one apparently exactly the same, and made in the very same way, in fact a twin gun, may burst before the hundredth round, or even at the first or second. From time to time, inventions of some process to make steel cheaply and of a homogeneous texture are announced. When some such announcement passes into realisation, it will be time for our Government to abandon a system which arms the country with guns at a moderate price, of a power which weight for weight is not surpassed by those made on any other system, and whose endurance may after proof be relied upon. Our gunners have no reason to be afraid of their own guns. Many of the continental Governments have been supplied with Krupp's steel guns, but very frequently they have burst in an unceremonious and unsatisfactory manner. On one occasion, the director of the Artillery Depôt at Tegel, near Berlin, was killed by the unexpected bursting of a steel 4-pounder gun. The manner of manufacture shows that steel is not calculated to bear a high dynamic strain. At the great gun factory at Essen the steel is hammered with steel hammers of immense weight, as much as 50 tons; but they are single action hammers, lifted up by steam, and allowed to fall by their own weight.* The 12-ton hammer used for forging our wrought-iron guns, which is

* The greatest achievement of Krupp's Gun Factory is a fifty-ton gun to fire a 1000lb shot, which he presented to the King of Prussia; a fitting present to make a monarch. It cost nearly 10,000*l.*, and occupied ten months of labour, night and day, in its manufacture. It was exhibited at Paris in 1867. Alas, that it should now return there under far different circumstances! But the manner of its construction cannot claim the merit of high scientific principles. A steel tube was formed sufficiently strong to resist the discharge; but as this would be so light that the recoil would hurl it into the air, like the toy cannons of our boyhood, it had shrunk round it enormous cast-iron rings or tubes. This was metal used for weight and not for strength. Whereas, the scientific principle very fairly laid down by the late Captain Blakely, R.A., is that "a gun should, if possible, be constructed in such a manner that each part of its mass would do its due proportion of work at the instant of firing."

driven down by steam power, has much greater dynamic force than the far heavier ones with which Krupp forges his steel. But the steel would break and crumble under a swift blow.

From what has been stated, it will be understood that the wrought iron now used for our guns, which was adopted upon Mr. Fraser's recommendation previous to his invention of our present system of construction, is of a soft and cheap character, instead of the hard, steely iron, which is much more expensive, and of which the guns were formerly made. The bars for coils are made in the Royal Gun Factories from scrap-iron, and from the stock of obsolete

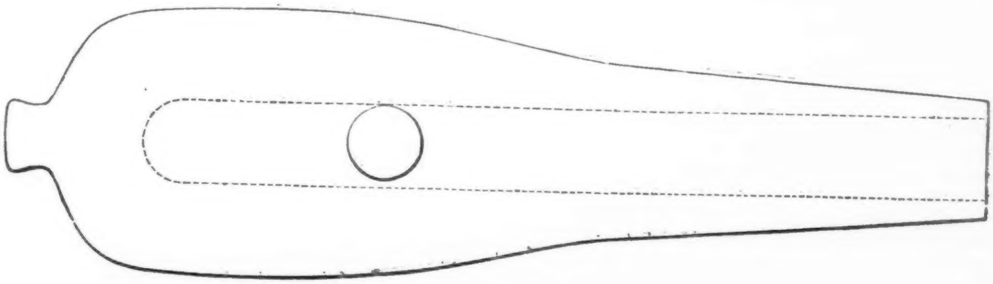


FIG. 2.

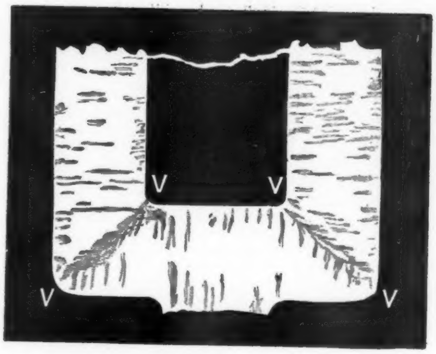


FIG. 3.

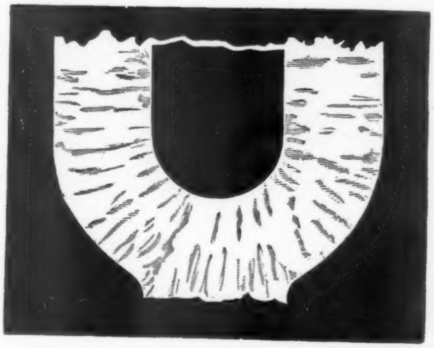


FIG. 4.

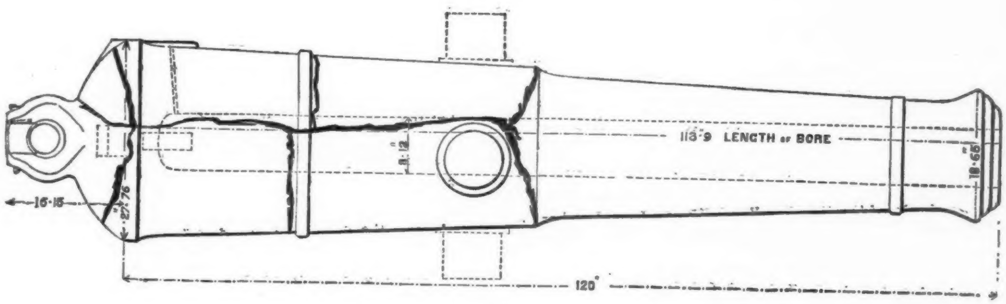


FIG. 5.

cast-iron ordnance. By this a very great economy is effected. Major Palliser has in another way utilised the old cast-iron guns by enlarging the bore and lining it with a wrought-iron and steel tube. The cost of this is about two-thirds of a Fraser gun of the same calibre; but they cannot be equal to a gun made entirely of wrought-iron.

In investigating the structure and materials for heavy guns, we see two great powers of nature wrestling before us: the strongest material and the greatest dynamic force, that of explosives, which man can use, and in the struggle some of her more recondite laws are exhibited in action. Each burst gun lying in the *cemetery* has its epitaph (if we could read it) written by the hand of nature, and telling accurately the cause of death. Those few that have been here deciphered and put together may

form, it is hoped, a not uninteresting page in her note-book.

The authorities for most of the statements in this paper are, besides Mr. Mallet's very valuable work before referred to, two exceedingly interesting papers in the Proceedings of the Royal Artillery Institution, by Captain F. S. Stoney, R.A., Assist. Supt. Royal Gun Factories, entitled "A Brief Historical Sketch of our Rifled Ordnance," and "The Theory of Gun Architecture."

NOTES

WE learn by telegraph that the Sicilian section of the Eclipse Expedition, under Mr. Lockyer's directions, arrived safely at Rome on the morning of the 12th; thanks to the capital arrangements made by Mr. Vignoles with foreign railways for the transit of the party. Through carriages for the observers and instruments were taken from Ostend over the Brenner Pass to Verona; and they would have been sent further had not a breakage occurred in passing over the Brenner. The party intended leaving Naples for Syracuse in H.M.S. *Psyche* in the course of yesterday. All the Governments are aiding to the utmost in their power.

WE are glad to be able again to report favourably of the state of both Sir R. Murchison and Prof. B. Stewart. The former has continued to gain somewhat in strength, and the progress of the latter from day to day has been as satisfactory as could be desired.

WE have to announce that Mr. C. L. Bloxam has succeeded the late Dr. W. A. Miller as Professor of Chemistry in King's College, London, and that Dr. Debus, F.R.S., has been appointed Examiner in Chemistry to the University of London, in the place of the late Dr. Matthiessen.

PRESIDENT WOOLSEY of Yale College, U.S.A., has announced his intention of resigning his office. He has been President of Yale for more than a quarter of a century.

L'ABBE MOIGNO has discontinued the publication of his *Les Mondes* owing to the scarcity of paper and the impossibility of sending his periodical to the subscribers. L'Abbé Moigno, however, attends regularly the sittings of the Institute. M. de Parville is now the scientific editor of the *Journal Officiel*, as in former times. He is the only contributor to that paper who has been kept in office, which is highly creditable both to M. de Parville and to the French Government. M. de Parville's contributions are pirated by almost every French paper published in Paris, the only exception being the *Liberté* when M. de Fonvielle was in Paris. Now, *Liberté* must do like others. Reports on scientific matters are published in the *Journal Officiel* with more regularity and space devoted to them than in former times.

M. DECAISNE, Professor of Agriculture at the Museum, has laid before the French Institute, of which he is a member, a scheme for the early growing of cabbages, radishes, &c., &c., which are to be sown in land richly manured, kept for a fortnight, and used stem and root, as a new description of vegetable. This diet is intended to protect Parisians against scurvy when the use of salt beef becomes still more frequent than it is now. The working of this scheme is superintended by M. Toigneaux, the editor of several agricultural papers. Different pieces of waste land close to the walls were appropriated, and vegetables of that description must be now actually on sale.

As soon as the investment of Paris was completed, the authorities took measures for preventing the destructive effects of shelling. Bills were printed and affixed to almost every house with directions for stopping the fire set up by the bursting of shells. Large tubs, filled with water, were placed on every floor of the large houses and private buildings. Although covered carefully with canvas, the water, having been left for weeks and weeks, became corrupted and fœtid. Proper instructions were given for stopping the infection by the using of charcoal. Two of these tubs are placed in the hall where the French Academy held its sittings, and two others in the *Salle des pas perdus*, by which visitors and members are introduced to it.

M. BARRAL, well known for the part he took in balloon experiments twenty years ago, has volunteered with his son for the balloon service. M. Barral was for many years the editor of the *Presse Scientifique*, a periodical which was discontinued a few years ago.

THE *Société Chimique* continues its sittings, devoted exclusively to warlike, culinary, and sanitary purposes. This body has offered a gun to the Provisional Government. It was built on new principles, and paid for out of the funds of the society, which do not flow out of the national exchequer, the *Société Chimique* being one of the very few French scientific bodies which are not supported by the State.

M. DUMAS is always in earnest for any improvement of diet. He has patronised the use of gelatine obtained from the carcasses of oxen, sheep, and pigs, by hydrochloric acid. The French Institute appears to have reversed the verdict given thirty years ago against the gelatine as proposed by D'Arcet, the only difference being that gelatine is not now prepared by steam, but by the action of acid on animal products, and that a new name, *osseine*, is given to the substance. He has also supported a scheme for grinding the whole of the corn, except the exterior coating, and the making of the flour so obtained into bread. But there is so large a quantity of corn and flour at Paris that the Government, although approving the scientific principles of this new method of grinding corn, declared the suggestion to be useless for the moment.

THE same answer was given to another suggestion, relating to the roasting of the corn for making a kind of gruel called *bouillie romaine*. It appears that this was the diet of the Roman legions, and that the gruel so obtained is very acceptable indeed. A kitchen for public distribution was said to be opened, but Government interfered, thinking, very properly, that it would be good to delay such steps for many weeks. They will use it only if the siege is prolonged so long that there is some danger of actual starvation.

M. BERTHELOT, although not a member of the French Institute, is the president of a standing committee for using scientific discoveries in the defence of Paris. That committee holds its sittings at the Ministry for Public Instruction, of which M. Jules Simon is the head. Many valuable suggestions have been adopted by that committee, which was closely connected with the Committee of Barricades, presided over by Rochefort.

M. JAMIN, the celebrated Professor of Natural Philosophy at the Sorbonne and member of the French Institute, has enlisted as a private in the artillery of the National Guard, and is doing his duty regularly, although begging for a weekly authorisation from the lieutenant in command to enable him to attend the sittings.

THE two Becquerels, father and son, have left Paris, and their place is filled by supernumeraries. Some papers have remarked very sharply upon it, and asked for the discharge of the younger.

THE following notification has been issued from the Home Department respecting the International Exhibition of 1871, dated Simla, October 11, 1870:—His Excellency the Viceroy and Governor-General in Council has been pleased to nominate

the following gentlemen to form a Central Committee to assist the efforts of private individuals and others who may be willing to forward the objects of the Annual International Exhibition of Select Works of Fine and Industrial Art and Scientific Inventions, to be held at South Kensington on the 1st of May, 1871: President, the Hon. Sir Richard Temple, C.S., K.C.S.I.; Members, his Highness the Maharajah of Jeypore, G.C.S.I., the Hon. B. H. Ellis, C.S.; Major-General the Hon H. W. Norman, C.B.; the Hon. J. Bullen Smith; the Maharajah of Vizianagram, K.C.S.I.; Mr. W. G. Romaine, C.B.; Mr. E. C. Bayley, C.S., C.S.I.; Colonel the Hon. F. Thesiger, C.B.; Mr. Allan Hume, C.S., C.B.; Mr. H. Rivett-Carnac, C.S.; Lieut.-Colonel Baigrie, B.S.C.; Major O. T. Burne, Private Secretary to his Excellency the Viceroy. Honorary Secretary, Mr. H. Rivett-Carnac, C.S.

AT the meeting of the Royal Geographical Society, held on Nov. 29, a paper was read "On the Geography of the Sea Bed," by Capt. Sherard Osborn, R.N. The author gave an account of our present knowledge of the configuration of the bed of the ocean, as derived from Admiralty surveys and submarine telegraph expeditions during the last fifteen years. His explanations were illustrated by a number of diagrams showing sections of the North Atlantic and other oceans. It has been definitely ascertained that the greatest depth of the ocean does not reach 3,000 fathoms in any part where telegraphic lines have been laid. The bed of the North Atlantic consists of two valleys, the eastern extending from 10° to 30°, the Western from 30° to 50° West longitude. The extreme depth of the eastern valley is under 13,000 feet, which is less than the altitude of Monte Rosa. This valley has been traced southward to the equator. It is separated from the western valley by a ridge in 30° West long., in which the average depth is only 1,600 fathoms. This ridge terminates to the north in Iceland, and southward at the Azores, so that it is volcanic in its character at both extremities. Its extreme breadth appears to be under 500 miles, and the Atlantic deepens from it on both sides. Explorations carried on in the Mediterranean, the Red Sea, and the Indian Ocean, showed similar uniformity in the level of the sea-bottom; and the general conclusions arrived at by Capt. Osborn were that in the deep sea there is an absence of bare rock, and that there are no rough ridges, canons, or abrupt chasms. Moreover, that the bed of the deep sea is not affected by currents or streams, even by those of such magnitude as the Gulf Stream; but that it rather resembles the prairies or pampas of the American continent, and is everywhere covered with a sort of ooze or mud, the *débris* of the lower forms of organic life. In the course of the discussion, Professor Huxley said that, viewed on a great scale, there would be but slight difference between the large general features of the ocean bed and the dry land; but that the smaller features would be different, as the effects of denudation would not appear in the deep ocean bed. To the naturalist, the observations of the telegraphists were of great importance, as showing the existence of low forms of animal life in the deepest seas; and recent discoveries had shown that the most characteristic organisms of the deep-sea beds, named coccoliths and coccospheres, existed at all depths, even in shallow shore waters, and were also found fossil in sedimentary rocks of all epochs—a discovery of great interest, as confirming the view of the uniform conditions of submarine deposits in all ages of the earth's history. He was opposed to the view that the animals found living in the dark regions of the lowest sea depths depended for light upon the phosphorescence of some of the species, and saw no reason for concluding that they could not, like fungi, exist without light. He also doubted the accuracy of the very low temperatures said to have been found at great depths, and thought that those taken in the Indian Ocean might be explained by the fact that they were taken with thermometers not rectified for pressure.

AT a meeting of the Scientific Committee of the Horticultural Society, held on the 7th inst., a remarkable paper was read by Mr. Andrew Murray, on the subject of Mimetism, especially as exhibited in the instances of the South American butterflies, which have already been discussed in our columns. Mr. Murray adduced a number of arguments which he considered told against the theory that the Mimicry had been produced by Natural Selection, and attributed it to Hybridisation. We hope to be able to publish the paper in a future number.

A CONFERENCE of gentlemen interested in Scientific Education was held in the Royal Institution, Liverpool, on Tuesday night, the 6th inst., and unanimously passed a resolution declaring the advisability of establishing a Science College in that town, the cost of which was estimated at about 50,000*l.*, and a committee was appointed to take steps with the view of carrying out the object. Possibly the recent meeting of the British Association in Liverpool may have given an impetus to so laudable a design, which we hope may be successfully carried out.

A NEW quarterly journal is about to be published by Messrs. Groombridge and Sons, under the title of *The Landowner and Farmer's Note Book.* It will aim at presenting a well-arranged series of notes and suggestions in connection with estate and farm management.

MESSRS. LONGMAN intend to issue early in 1871 a Supplement to "Watts's Dictionary of Chemistry," bringing the record of chemical discovery down to the end of the year 1869. It will form a volume of about 900 pages, and many of the former contributors have consented to furnish additions to their articles.

THE new general Government of Elsass proclaimed by the King of Prussia, embraces, in addition to the departments of the Rhine which constituted the former Alsace, the arrondissements of Saarbourg, Château Salins, Saarguemines, Metz, and Thionville, taken from the departments of Moselle and Meurthe, in Lorraine. With the addition of these districts, the boundary of the new province marks out very nearly the German-speaking part of France. The fortresses of Thionville and Metz in the north, the natural barrier of the Vosges Mountains, and again the fortress of Belfort, in the south, will then protect the frontier of Germany towards France. From an article in the December number of *Petermann's Mittheilungen*, we learn that the new government has an area of 5,825 English square miles. This space is represented in English soil very nearly by the counties of Hants, Surrey, Sussex, and Kent, and it cuts off a thirty-sixth part from the whole of France. The fertility and industries of Elsass, however, support a population of 1,638,500, or a twenty-third part of the inhabitants of France, and the density of its population is comparable to that of the plains of China. In the new government the purely German-speaking area measures 4,425 square miles; the purely French parts, which lie chiefly round the fortresses in the north and south, are together 985 square miles in extent, and the territory of a mixed language, which lies in patches between, makes up an area of 415 square miles.

THE series of botanical diagrams by Professor Balfour, of which we noticed the first some time since, is now issued in a complete form by Messrs. W. and A. K. Johnston, and comprises four large sheets 4ft. 2in. by 3ft. 6in. on rollers and varnished. They supply a marked desideratum for botanical teachers and lecturers, supplementing, but not replacing, Prof. Henslow's diagrams published by authority of the Science and Art Department. In the latter we have delineations of a plant belonging to each of the most important natural orders, with details of their structure. In Prof. Balfour's diagrams, each separate organ is taken, and the different variations of its form and structure illustrated. The first sheet showed the organs of plants generally, the tissues, root, and

stem; in the second we have leaves and their modifications; in the third, inflorescence and the whorls of the flower, while the fourth presents us with the pistil, ovule, and seed, and the organs of flowerless plants. Many of the drawings are, strictly speaking, diagrams, that is, artificial representations of typical structure. They are well and clearly drawn, and sufficiently coloured to add to their lifelikeness. With these sheets, and either Henslow's series, or better still, a few hand-made ones on a larger scale, and actually taken from life, the botanical lecturer would be well provided; and the comparatively low price at which they are published ought to insure for them a very large sale. The handbooks which accompany them are admirably drawn up.

FROM China samples of Poyang Lake coal have been forwarded to the Admiralty authorities in the hope that they may be found useful for the navy in that station.

THE Government of India has taken further measures for carrying on coal borings in Central India, but only in Berar, and not in the Nizam's dominions.

THE Indian Government have again deputed Mr. T. W. H. Hughes, of the Geological Survey Department, to prosecute the investigation of the Wurda River coal-beds in the Central Provinces, and to report on the line of railway best calculated to develop the collieries.

OUR Darjeeling hill district of India is likely at length to experience a development of its mineral produce, instead of being left to depend on tea culture. Limestone, copper, and iron have been discovered not only in the Darjeeling territory, but also in the lately annexed Dooars of Bhootan. The Nepaulese have applied to work the iron ore, and the Commissioner of Kooch Behar has been authorised to divide the tract into sections, and to let out the mineral privileges by the year to the highest bidder.

A VERY important discovery of silver is reported from Copiapo, in Chile, which has a large silver district. El Carmen Mine is now producing 16,000 marcs of silver per month; that is 128,000 ounces, worth about 32,000*l.*

MR. JAMES GALBRAITH sends to the *Ararat and Pleasant Creek Advertiser* (Victoria), of Sept. 16th, an account of some huge boulders found near the townships of Hamilton and Coleraine, which he believes to have been deposited there by the agency of ice. He states that the whole of the western district of Victoria is covered with boulder clay. The ironstone gravel called buck-shot, which is found in patches on the surface and at a short distance below the surface, all over the plains to the south of Ararat and Beaufort, is, no doubt, a deposit from floating ice. The "grey stone" on the Ararat and Port Fairy road has been floated to its present position by ice; and a number of granite boulders on the road between Moyston and Ararat, some of them a great deal larger than the "grey stone," must have been brought to their present position by the same agency. No polished or striated rocks have, however, as yet been detected in the colony.

WE learn from the *New York Times* that an ice machine, constructed on Tellier's principle, is now being exhibited in the United States. The material used is gaseous ammonia, which is liquefied by pressure. It is said that the machine will make 100 tons a day, at a cost of four or five shillings per ton; and that the ice made by it is transparent and durable. The cooling effect of the vaporisation of liquefied ammonia may be applied to chambers containing articles of food to be preserved, or refrigerators might be constructed on any scale. The holds of ships could thus be converted into refrigerating chambers with the greatest ease, offering a ready means for the conveyance of meat from one port to another in a wholesome state.

BALLOON ASCENTS FOR MILITARY PURPOSES

II.

BEING detained in England by unavoidable circumstances for some time longer than I expected, I will try to give the British public an adequate view of the action of our French Institute in the matter of balloon navigation; and will confine my criticism to an exposition of M. Dupuy de Lome's own views, which were supported by the Government, so far as to give to this learned man a credit of nearly 2,000*l.* for the construction of his balloon. Perhaps the observations I have published in the *Liberté* and offered to some of his assistants in private conferences, have produced some alteration in the original scheme. It is a matter of which I cannot be made aware by any means, and I must suppose things to be as they were when I left Paris in my own balloon.

M. Dupuy de Lome's balloon was to be constructed out of silk, and I understood that people were engaged in looking after the stuff in different Parisian fancy shops. But it requires a great deal of search to find silk enough to construct a large balloon somewhat larger than Mr. Coxwell's "Research" and having a larger surface besides in consequence of its intended elongated form, the spherical form being, as is known, the one which offers the largest capacity for the smallest surface.

It may be well to remark that balloons are somewhat elongated in the present fashion of building them, the elongation being vertical instead of horizontal as required by M. Dupuy de Lome's scheme. But the elongation of the balloon is a thing of which we will speak more fully in another place.

M. Dupuy de Lome was not afraid to have his balloon shaped like an egg, or, rather, like a fish with two tails and no head, but he did not wish to try it with pure hydrogen gas. It is not because he thinks that hydrogen gas is too expensive or too difficult to prepare, it is only because he supposes that hydrogen gas would escape in spite of varnishing. I cannot agree with him in this respect, not only because my friend Giffard's balloons have proved perfectly hydrogen-tight, but principally because ordinary balloons filled with hydrogen have done good service. Amongst these balloons I may mention the one which conducted the unfortunate Worth to be lodged in a Cologne cell, not by any fault of its gas-holding power, but merely because aëronauts were foolish enough to open their valve when Prussians were firing at them, and preferred trusting to Prussian humanity to relying upon the dark mantle of the night.

Official people engaged in ballooning seem to have strong prejudices against hydrogen gas, as may be noticed from their acts; the battery I had caused to be constructed for filling poor "Liberté," having been wholly disregarded by them as unfit for use.

Many inventors have published descriptions of working aërostats, but very few of them were really professional aëronauts. I shall be justified by facts in stating that scarcely any of them was in a position to form an adequate idea of the most essential features of any really scientific scheme. Almost everyone of them has forgotten that the principal condition of success is an easy working. M. Dupuy de Lome has not avoided that fault, and his balloon is to be shaped, as we have remarked, like a fish, which is to be kept in an horizontal position. That condition is very difficult to accomplish when you have to look to so many other things at the same time. M. Dupuy de Lome is so well aware of the difficulty of having his balloon always progressing horizontally, that he proposes to get rid of it by keeping the balloon always filled either with gas, or with ordinary air by means of a pump. It is an instance of avoiding our old French saying, *Le remède est pire que le mal.* This saying is so much the more justified, that M. Dupuy de Lome is not contented with sending air into his balloon when it is required to fill it. He has constructed ready for the purpose a special balloon, which is to be enclosed within the large one, and which being alternately filled and unfilled according to the requirements of the external pressure, keeps the balloon always in a state of full expansion. The pressure inwards is always a little greater than the pressure outwards, which is in itself a new objection, as this artificial pressure increases the rate of escape for the gas by the small holes which are unavoidably so numerous in the whole surface. Besides, if there are some defective places, they may probably be opened by that pressure.

As you may understand from this explanation, M. Dupuy de Lome was very careful, and his scheme is worked out with every required detail, to show the corollaries which follow from the first assumptions. M. Dupuy de Lome being a very clever ship con-

structor, is ready to meet the difficulties, but he was not willing to avoid them at once by having a more simple scheme to work out. It is so much the more to be wondered at, if this clever aëronaut has not adopted this policy, inasmuch as he does not profess to go against the wind, but to design a contrivance which may help aëronauts in using the wind for a certain purpose, as returning to Paris from a town located at some distance, as Lille, Le Mans, &c. M. Dupuy de Lome intends to attain the desired result by making a definite angle with the direction of the reigning wind, which supposes on the part of the aëronaut some previous knowledge of the state of atmospheric currents, their change of duration, and different directions at different elevations; the principal feature of his intended directing balloon being the grand idea of having the motive power like an auxiliary implement for giving to the balloon differential motions. It does not, of course, prevent the aëronaut from using the deflections and variations of the wind according to the elevation of his balloon at any moment. The working out of these aërial manœuvres supposes necessarily that aërial navigators can know at any moment the place where they are. It requires constant attention from the aërial travellers, who are supposed to be supplied with every possible instrument for looking over the land and finding the places on the map prepared for that very purpose. It would be of itself a most interesting chapter, the better construction of such maps, as well as the determination of the means by which public authorities could give warnings to the aërial travellers. But in the present state of things, I should not be justified if I did not abstain from giving details which may prove useful to the invaders of my native land. I will be satisfied with saying, moreover, that the taking of the point in sailors' fashion is quite out of the question. The only condition is the view of the land remaining always at the command of the observer, or only being lost for short intervals, during which more than the usual attention is required. I have invented an apparatus called an *aërial planchette*, for helping aëronauts in the determination of their way, but from the experience of my last excursion I have lost every confidence in my instrument. I think that it is quite useless; the only thing required being good maps and better eyes, helped by powerful opera-glasses. The power of these can be enlarged by a very simple contrivance, which I mention merely to show that I know what is still to be done in this respect.

The question of the motive power to be employed is not of so much importance as was supposed at the first instance; and it is very easy to understand why, admitting that we want only a slow motion. I should not object, of course, to a quick displacement; but I am satisfied it cannot be obtained except by contrivances very difficult to imagine, and even more to realise, and besides it is not required for the special purpose in view, the returning to Paris from a French city which German armies have not occupied. The rate of motion will be improved by degrees, and will not amount to a large increase, except by the use of steam engines, which requires a great many preliminary steps to prevent the gas of the balloon from being lighted by the fire from the furnace, which would lead to the destruction of the balloon and of the aëronauts. The simplest contrivance will be the best if it proves useful. I should advise to arrange the motor apparatus so that it could be used by hand, and, besides, that it could be very easily thrown overboard like ballast in case of need. These two conditions being of much importance for our purpose, if I start for Paris, which I hope will be the case, I shall adhere strictly to them.

I have no objection to use a rudder, which may be constructed in a manner very easy to understand, but I should feel very much disposed to dispense with it. I think that a propelling machine may be arranged so that no rudder at all will be put into operation. I am afraid to give more substantial explanations, which could hardly be offered without giving a full knowledge of my intended construction, which is not my purpose.

The contributions of M. Dupuy de Lome to the *Comptes rendus*, have been sharply commented upon by the *Aeronaut*, a special paper devoted to the aërial navigation worked out by the *plus lourd que l'air* system, as inaugurated by Lalandelle and Nadar, and many other gentlemen of very little or no scientific qualifications. But every scientific man must confess that these interesting papers constitute by themselves a very valuable acquisition to general knowledge, independently of their special aim. M. Dupuy de Lome has given at the same time many calculations to show to what elevation a given balloon can attain under the conditions he has adopted, viz., constant fulness, and a certain excess of internal pressure for giving it a stability of form and of equilibrium.

Without quoting M. Dupuy de Lome's paper, and even correcting some parts of it, I will give a rough idea of the analytical questions involved in the calculation of the circumstances of an aërostatical ascent. I suppose, firstly, that the air has no horizontal movement at all, and that the only questions are to ascertain the elevation which the balloon may reach, the time that may be required, and the velocity with which the balloon ascends at the various points of its vertical course, as well upwards as downwards. There are besides two accessory suppositions which are required. The first is, that the balloon does not lose its gas by any *exosmose* during the experiment; and the second is that the temperature of the air, as well as the degree of moisture, is not altered in any degree. These conditions are hardly to be expected, but they are required for mathematically working out the analytical equations.

M. Dupuy de Lome, however, would not have been placed in a position to proceed with his calculations, if he had not very cleverly evaded the consideration of the other conditions, which are insuperable, owing to our imperfect knowledge of the atmosphere, as we shall see hereafter. W. DE FONVIELLE

PROF. WILLIAMSON'S INAUGURAL LECTURE TO THE FACULTY OF SCIENCE AT UNIVERSITY COLLEGE, LONDON

THE great value of scientific knowledge as a means of culture, a promoter of civilisation, and one of the most powerful levers of national prosperity, seems at least to receive its due acknowledgment in the land of Bacon and Newton, Sir Humphry Davy and Faraday. The recent efforts to introduce science into the public schools of England appear as a consequence of this recognition. A great variety of opinion, however, exists as regards the mode by which scientific knowledge ought to be imparted to the people. Some believe that a young farmer ought to be taught agricultural chemistry, the man at the furnace the chemistry of iron melting, and the maker of colours the chemistry of colours. This is what is called by many "technical education," for the promotion of which great efforts have been made of late. Technical education in this sense would be a mistake. It would not be difficult to show that it is impossible to teach, with any considerable effect, agricultural chemistry, which is the application of certain chemical principles to Agriculture, without a knowledge of these principles. These, with others, form part of the science of Chemistry, and it is clearly absurd to isolate them and teach their application in some particular case. The working classes of England want a knowledge of the elements of pure science; and they are sure to make useful application of this knowledge as soon as an opportunity offers itself. In this sense Professor Williamson expresses himself in his admirable lecture, "A Plea for Pure Science,"* which on account of its sound views on some of the most important questions of the day, we recommend to the attention of our readers. On p. 3 Prof. Williamson says, "Now there are in education two great national parties, corresponding to the two most different points of view from which the preparation of any young person for his career in life can be considered. I submit that the progress of education will be proportional to the consistency and completeness with which the functions of these two parties are systematised and developed.

"The first step towards that object is to know and acknowledge their respective characteristics.

"One party looks to the special duties for which a young person has to be prepared and the material difficulties which he is expected to encounter. They see that the success and happiness of each individual are proportional to the efficiency with which he discharges the aggregate of the special duties of his station in life; and they accordingly recommend that each youth be placed in circumstances which may induce him to imitate accurately the doings of some one who is known to be successful in a station such as he is intended to occupy. The other party looks to the general qualifications which experience has shown to be most important for any success in life; and to the means by which they are most effectually acquired. They see that men who have been taught to understand and apply the best-known general principles are able to master a given set of practical details with a facility and completeness which other men do not attain. They know that a general principle of nature is an instrument of

* "A Plea for Pure Science." By A. W. Williamson, Ph.D., F.R.S.

thought applicable to the explanation of an infinite variety of phenomena, and they recommend that every one be placed in his youth somewhere where he may best learn such general principles. The first party takes little account of the development of the mental powers as a distinct object to be aimed at in education; the second attends but little to special operations.

"The former recommends special or technical instruction with a direct view to material success in a particular business, the direct aim of the latter is to educate and strengthen each individual mind. The essential differences between them arise from the fact that they look at the question from opposite sides, and respectively put forward what they see most clearly."

After this sketch of the outline of the characteristics of the two great parties, Professor Williamson describes some results of the arrangements recommended by them respectively. The great aim and object of science is to systematise our knowledge; and the discovery of an idea which helps to arrange any considerable number of facts in such a manner as to facilitate their apprehension, is the highest result of scientific work. We are then led in an admirable manner from the periodical disappearance of the sun to the law of gravitation as a model of scientific work. But it must not be supposed that the application of science to practical purposes is the greatest reward of scientific work. We read on page 12—

"To any one possessing a clear and vigorous mind, the acquisition of an idea which helps to explain things is a source of intense pleasure. He feels that it enlarges the scope of his mind, and gives him new power; and when facts, previously unintelligible, are explained by the aid of such an idea, they immediately acquire vivid interest and special value to his mind; such facts seem to gain life by acquiring an intelligible place in the system of nature.

"I believe that the triumphant feeling of the enlargement of his faculties which is experienced by a real student in the acquisition of any new law or principle of nature, is the most direct and vivid reward of his labours. The best and truest, as well as the most rapid progress in study, is made for the sake of that reward. Whoever has once enjoyed it will gladly seize any opportunities of wrestling, as far as his powers permit, with new difficulties, and mastering new ideas.

"It has been said that the happiness of an individual results from the due exercise of his various faculties, and this is surely not least true of the highest faculties of the mind; certainly those who have the power of understanding the wonders of nature derive great happiness from learning to employ it. It is like the pleasure which a man of healthy and vigorous frame experiences in climbing a mountain peak, and in enjoying, in proportion as he rises, a wider and more commanding view of things below."

Our space does not permit us to follow the author into the study of the conditions under which science flourishes, and does most effectively the good which it has to do, and we must content ourselves with a quotation of his description of the usual results which follow a system of special professional pupilage:

"But it often happens (page 15) that a man learns thoroughly the particulars of a business, as practised in some one successful case, and although he has sufficient capital and industrious habits, fails to realise similar results elsewhere.

"For instance, he has learnt and practised the management of a particular farm, and then takes a lease of one in another district. He purchases implements exactly similar to those which he has been using, and gets sheep and cattle of the same breeds. He adopts the same rotation of crops, and spares no pains to make everything go on precisely in the same way as that to which he has been accustomed.

"His first year is unprofitable; but he looks forward hopefully to better results, when things will have got into better working order. But the second and third year only bring more losses, and he is ultimately compelled to give up the farm.

"The next tenant is perhaps a man who has learnt the management of an adjoining farm, which happened to be in size, in soil, &c., very much like it. He uses ploughs and other implements which have been found to suit the soil, and gets breeds of sheep and cattle which thrive in that part of the country. He adopts the same rotation of crops and system of manuring which is customary in that district, and carefully imitates what he had seen to succeed, under conditions similar to his own. The result is that he goes on steadily year after year making a fair profit.

"Both of these men were mere servile imitators of what they had seen, and both had been taught to believe that a practical man ought to be nothing more, and that all theories are dangerous. Yet one failed while the other succeeded. We ought not to be surprised at the failure of the one, so much as at the success of the other, which was due to the exceptional circumstance of his finding a farm which admitted of being profitably managed upon exactly the same system."

Men of business, in the opinion of our author, ought to have not only a knowledge of things, but also of principles; and they must be able to use their knowledge of these things and principles for the purpose of bringing about special results; in fact they must have a knowledge of the laws of nature, and skill in the methods of applying that knowledge to experimental purposes. Their power of bringing about the material results from which they derive profit is proportional to the amount of such knowledge and skill which they possess.

And here we must break off our account of an essay which, no doubt, will greatly help to clear up our ideas about scientific and technical education.

ZOOLOGY

Researches on the Amœbæ

The minute masses of protoplasm termed Amœbæ have been recently examined by M. V. Czerny, in relation to their resistance to reagents, and his results have been published in Schultze's "Archiv für Mikroscopische Anatomie," p. 158. He finds that the power of resistance to the action of solutions of common salt varies considerably in different individuals. In solutions containing one part to four hundred of water none died, but in those containing one to three hundred many died; whilst others, especially the quiescent ones, still lived in solutions containing one per cent., or more. None, however, survived when suddenly placed in a two per cent. solution. It is interesting to observe, however, that these lowly organised beings possess a certain adaptability to external conditions—a power of acclimatisation as it were, enabling them, if these conditions undergo slow alterations, to accommodate themselves to their new and modified surroundings. Thus, if the strength of the solution were gradually raised, it was found that some Amœbæ could continue to exist in solutions of four per cent. of salt. M. Czerny corroborates the statements already made by Kühne, that, on exposure to weak saline solutions, Amœbæ thrust forth numerous extremely delicate processes resembling cilia, and that they undergo fission. It is worthy of remark that the partially double contour of the *Amœba bilabiata*, which has led to the admission of a double contoured membrane in this species, is resolved, when examined with a No. 10 Hartnack immersion lens, into a number of closely aggregated, extremely minute toothlets, which, like the stinging cells, cover the whole surface of the body.

M. Engelmann has made some observations on the electrical excitation of the Amœba of the Arcella in the fifth volume of the "Nederlandische Archiv voor geneesen Natuur kunde," p. 28. His investigations were conducted in a moist gas chamber, with unpolarisable electrodes, the stimulus consisting of a single opening induction shock. In *Amœba diffluens*, as Kühne had showed previously, the results of the excitation differ according to whether the individual is in the active or in the quiescent condition. In the former condition, that is, when the animal is elongated or club-shaped and homogeneous, and its protoplasm seems to be flowing continuously in one direction, a very slight stimulus retards or altogether arrests the current, though it speedily recommences, the period of arrest not exceeding at most five seconds. If, however, the stimulus has been a little stronger, in addition to the arrest of the protoplasmic movements, a condensation and shortening of the whole animal occurs, and at a subsequent period perfectly transparent projections form in the anterior part of the body, into which the highly granular protoplasm streams until the original form of the Amœba, which sometimes moves forward with great rapidity, is re-established. The length of time occupied in these changes may amount with tolerably strong currents to about from one to two minutes. If the excitation be applied to the quiescent animal, the protoplasmic movements first cease, the mass assumes the spherical form, but instead of remaining quiescent, it now begins to move from place to place, in which active condition it may remain for a long time. From these experiments, and from others performed upon specimens of Arcella, containing air-vesicles M. Engelmann draws the conclusion that protoplasm, in consequence of electrical excitation, transitorily assumes the mechanical properties of a fluid.

CHEMISTRY

Constitution of Arbutin

Hugo Schiff has made some interesting experiments relating to the constitution of arbutin. This substance splits up into glucose and hydroquinone, just as salicin is resolvable into glucose and saligenin (Strecker). The relations between salicin and arbutin may be represented by the following formula:

$$\begin{array}{rl} & O \\ C_6H_7 \Big\{ & (OH)_4 \\ & O \\ C_6H_4 \Big\{ & CH_2\,.\,OH \end{array} \qquad \begin{array}{rl} & O \\ C_6H_7 \Big\{ & (OH)_4 \\ & O \\ C_6H_4 \Big\{ & OH \end{array}$$

Salicin (Glycosalicyl alcohol). Arbutin (Glycohydroquinone).

The hydrogen in the oxhydryls of the glucosic portion of arbutin may in fact be replaced by acid radicals, just as the author formerly showed in the case of salicin (Zeitschr. (2), v. 1. 52). Moreover, the hydrogen belonging to the hydroquinone in arbutin is easily replaceable; whereas in salicin the hydrogen belonging to the saligenin is not capable of substitution.

Benzoyl-arbutins are obtained by means of benzoyl chloride; *acetyl-arbutins*, with acetyl chloride or acetyl oxide, which act at 60°–80°. The ultimate products of the reaction separated from the resulting solutions, after cooling, by means of ether, contain five acid radicals, and have this composition:

$$\begin{array}{rl} & O \\ C_6H_7 \Big\{ & (O\,.\,C_2H_3O)_4 \\ & O \\ C_6H_4 \Big\{ & O\,.\,C_2H_3O \end{array} \qquad \begin{array}{rl} & O \\ C_6H_7 \Big\{ & (O\,.\,C_7H_5O)_4 \\ & O \\ C_6H_4 \Big\{ & O\,.\,C_7H_5O \end{array}$$

Pentacetyl arbutin. Pentabenzoyl-arbutin.

They are colourless bodies, insoluble in water, slightly soluble in ether, more soluble in hot alcohol, from whence they crystallise on cooling in small shining needles. The acid radicals may easily be taken out again by boiling with weak bases. Together with the pentabenzoylated compound, the author likewise obtained *dibenzoyl-arbutin*, in which the hydrogen might be further replaced by acetyl.

Dinitro-arbutin dissolves easily in acetic oxide, and is converted into

$$\text{Pentacetyl-dinitro-arbutin} \quad \begin{array}{rl} & O \\ C_6H_7 \Big\{ & (O\,.\,C_2H_3O)_4 \\ & O \\ C_6H_2(NO_2)_2 \Big\{ & O\,.\,C_2H_3O \end{array}$$

which may be separated from the acetic acid solution by water, and crystallised from hot alcohol in fine needles, insoluble in water, slightly soluble in ether. The alcoholic solution heated with sulphuric acid yields glucose, acetic ether, and dinitrohydroquinone, easily recognisable by the splendid colour which it gives with caustic alkalies. Dinitro-arbutin forms with basic lead acetate a crystalline orange-coloured lead-compound, in which the hydrogen of the oxhydryl is replaced by lead. Arbutin gives no precipitate, even with an ammoniacal solution of lead-acetate.

Recently precipitated silver-oxide is reduced, even at ordinary temperatures, by an aqueous solution of arbutin. On adding freshly prepared silver carbonate to a solution of arbutin heated to 50°—60° as long as carbonic acid is evolved, and heating for a short time with excess of the silver carbonate, a yellow solution is obtained, which no longer contains arbutin; but on separating the dissolved silver with a few drops of hydrochloric acid, and filtering, a solution is obtained, from which alcohol precipitates white flocks consisting of a compound formed by the union of 2 molecules of arbutin minus 2 atoms of hydrogen, viz.—

$$\begin{array}{c} \text{Diarbutin} \\ \text{or} \\ \text{Glycoquinhydrone} \end{array} \quad \left.\begin{array}{rl} C_6H_7O \Big\{ & (OH)_4 \\ & O \\ C_6H_4 \Big\{ & O \\ C_6H_4 \Big\{ & O \\ & O \\ C_6H_7O \Big\{ & (OH)_4 \end{array}\right\} = C_{24}H_{30}O_{14}$$

This compound may be regarded as the glucoside of quinhydrone (green hydroquinone); it is related to arbutin in the same manner as helicoidin to salicin. Glycoquinhydrone is not at all bitter; it forms acetyl-derivatives when treated with acetic oxide, and an orange-coloured nitro-product with nitric acid. The latter, when decomposed in alcoholic solution by sulphuric acid, does not yield any substance that turns violet with potash. By means of zinc and sulphuric acid, hydrogen may be again added; and dinitro-hydroquinone thereby produced.

A solution of arbutin produces with ferric chloride a deep blue colour, which gradually disappears. None of the derivatives of arbutin above described exhibit this reaction.

Schiff also finds that *amygdalin* contains seven, and *phlorizin* five oxhydryl atoms, the hydrogen of which may be replaced by acetyl. Hence he assigns to these bodies the following formulæ:

$$\begin{array}{rl} & O \\ C_6H_7 \Big\{ & (OH)_4 \\ & O \\ C_6H_7 \Big\{ & (OH)_3 \\ & O \\ & O \\ C_7H_6 \Big\{ & CN \end{array} \qquad \begin{array}{rl} & O \\ C_6H_7 \Big\{ & (OH)_4 \\ & O \\ C_6H_3 \Big\{ & OH \\ & O \\ C_8H_8 \Big\{ & CO\,.\,OH \end{array}$$

Amygdalin. Phlorizin.

(Zeitschr. f. Chem. (2) v. 519. Ann. Chem. et. Pharm. cliv. 237.)

SCIENTIFIC SERIALS

Poggendorff's Annalen, 1870, No. 7. The contents of this Number are:—(1.) "On the effect of Roughness of Surface on the Radiation of Heat," by G. Magnus. The author shows that the generally accepted explanation of the increased emission of radiant Heat by roughened surfaces, that it depends on a diminution of superficial density, is inadmissible. He attributes it to the refraction which takes place at the surface of emission, whereby the direction of the rays which leave the surface obliquely is changed. (2.) "On the Specific Gravity of Alcohol and of Mixtures of Alcohol and Water," by E. H. Baumhauer. A defence of the author's tables of the specific gravity of alcohol against Mendelejeff's criticisms contained in Poggendorff's *Annalen* for 1869, vol. 138. (3.) "On the Flow of Mercury through Capillary Tubes," by E. Warburg. The author's experiments prove that in glass tubes, whose diameter is a sufficiently small fraction of their length, the quantity of mercury which flows through them in a given time is directly proportional to the difference of pressure at the two ends, to the *fourth power* of the diameter, and inversely proportional to the length, but that it is independent of the absolute pressures at the ends so long as the difference remains constant. He concludes from these results that there is no friction, under the conditions of the experiments, between the mercury and the glass, but that the film of mercury in contact with the glass remains at rest while the inner portions flow through it. (4.) "Continuation of Investigations into the Electromotive Force between Liquids," by J. W. Müller. (5.) "On the Determination of the Proportion of Water in Glacial Acetic Acid," by F. Rüdorff. The author gives a table for deducing the proportion of water contained in acetic acid from the freezing point of the mixture. He gives 16·7° C. as the freezing point of pure acetic acid (without water), and finds that the presence of ½ per cent. of water lowers the freezing point by more than a degree. (6.) "On the Determination of the Freezing and Melting Points of Fats and other Compounds," by F. Rüdorff. The author points out the untrustworthiness of observations of melting points made, as they often are, by heating the substance to be examined in a capillary tube, or by coating the bulb of the thermometer with it. He recommends the observation of the freezing point, with a thermometer whose bulb is actually immersed in the substance, as a means of establishing its chemical identity instead of observing the melting point. To ascertain whether the observed temperature is the highest at which solidification can occur, he notices whether it is accompanied by rise of temperature, which always takes place if the body has been cooled below the normal freezing point. (7.) "On the Phosphorescence of Rarefied Gases after the passage of an Electric Discharge," by E. Sarasin. The author finds that the presence of oxygen, either free, or combined in a compound which is probably decomposed by the discharge, is an essential condition of the occurrence of the phosphorescence, and shows that this phenomenon is probably connected with the formation of ozone. Sulphuric acid vapour favours the production of phosphorescence in a high degree. (8.) "On the Electromotive Forces due to the contact of different metals," by E. Edlund. When an electric current traverses the point of junction of two different metals, a quantity of heat is absorbed or produced per unit of time which is proportional to the strength of the current and to the electromotive force acting between the metals. The author refers on this point to a previous paper (Poggendoff's *Annalen*, vol. cxxxvii.); in the present communication he endeavours to estimate the comparative electromotive forces acting between different pairs of

metals by the heating or cooling effects of a current of measured strength. The junction formed of each pair to be examined was enclosed in the bulb of an air thermometer, and the difference between the expansions produced, when the current passed in opposite directions, was measured. The electromotive order of the metals deduced from the results did not agree with the order given by electroscopic observations (*elektrische Spannungsreihe*), but it agreed with the thermo-electric order, though the electromotive forces were not found to be proportional in all cases to the thermo-electromotive forces between the same pairs of metals. (9.) "On the Properties of Pictures formed by Photographic Lenses," by Dr. Hermann Vogel. The author calls attention to certain inherent defects of pictures formed by perfect photographic lenses, that is to say, defects not due to distortion or aberration in the lenses. (10.) "On the Velocity of Light in Quartz," by Victor von Lang, contains very careful measurements of the deviations produced by a quartz prism in the ordinary and extraordinary rays for various angles of incidence. Incidentally, a measurement of the ratio of the two coefficients of expansion of quartz is also given, deduced from the change produced by alterations of temperature in the refracting angle of the prism. (11.) "On the Specific Heat of Saline Solutions and Mixtures of Liquids," by A. Wüllner. The author disputes, on the authority of the experiments made in his laboratory by Dr. Schüller, Jamin's conclusion that when two liquids are mixed together, and therefore each of them is uniformly diffused through the whole of the space occupied by the mixture, the specific heat of each increases in proportion to increased space occupied by it. (12.) "On the Fusion of Leaden Bullets by striking against an Iron Plate," by Edward Hagenbach. This paper describes the melting of leaden bullets fired against an iron target, and contains a calculation showing that the kinetic energy due to the velocity assigned by "a competent military authority" is sufficient to account for the result. (13.) "An Experiment on boiling together two liquids which do not mix," by August Kundt. If steam is passed into liquid sulphide of carbon, or if sulphide of carbon vapour is passed into water, the resulting mixture of water and sulphide of carbon boils at 42·6° C., that is to say, at a temperature four degrees lower than the boiling point of sulphide of carbon alone. Also, if water and sulphide of carbon, which have been heated separately to between 43° and 46·6°, be mixed together, the mixture boils until its temperature has fallen to about 43°. These facts are in accordance with the observation of Magnus and Regnault that the vapour-tension of a mixture of two mutually insoluble liquids is equal to the sum of the vapour-tensions of the separate liquids. (14.) "On Microscopic Tridymite," by Ferdinand Zirkel. The author describes the characters of this mineral as seen under the microscope, and shows that it is of frequent occurrence in microscopic crystals. (15) "On Acoustical Attraction and Repulsion," by K. H. Schellbach, contains experimental proofs of the statement that "the sonorous vibrations of an elastic medium urge specifically heavier bodies towards the centre of disturbance, and specifically lighter bodies away from it."

Palæontographica. Beiträge zur Naturgeschichte der Vorwelt. Herausgegeben von Dr. W. Dunker and Dr. K. A. Zittel. Band xvii., Lief. 6, 1870. This new part of the well-known "Palæontographica" contains an interesting contribution to fossil entomology in the description of the species of diptera obtained from the brown coal of Rott in the Siebengebirge. It is from the pen of the distinguished entomologist, L. von Heyden. The species, which are figured, are forty-one in number, belonging to sixteen genera, and all but nine of them belong to the moisture-loving families of the monocerous group (*Tipulidæ*, *Culicidæ*, &c.). Of *Chironomus* there are five well-marked species, and no less than six different forms of larvæ and pupæ, and there is also the larva almost certainly of a species of *Stratiomys*.

The most important article in the *Journal of Botany* for December is a continuation of Dr. Braithwaite's Recent Additions to our Moss Flora, accompanied by two plates. Dr. Seemann continues his Revision of the Natural Order *Bignoniaceæ*, and Mr. Ernst gives Jottings from a Botanical Note-book, relating chiefly to Caracas plants. The other articles belong exclusively to specific British botany. With the new year it is intended to increase the amount of type in the journal by about one-third, without any corresponding increase in price.

SOCIETIES AND ACADEMIES

London

Zoological Society, December 6.—Robert Hudson, F.R.S., V.P., in the chair. The Secretary read a report on the additions to the Society's menagerie during the months of October and November, amongst which particular attention was called to an example of Geoffroy's Cat (*Felis Geoffroyi*), from Paraguay, purchased Oct. 10, and a specimen of the Antarctic Wolf (*Canis antarcticus*), from the Falkland Islands, presented by Mr. H. Byng, Acting Colonial Secretary of that colony.—An extract was read from a letter received from Dr. R. C. Cunningham, giving particulars of the habits of a Manatee, as observed by him in the public gardens at Rio. —A ninth letter was read from Mr. W. H. Hudson, on the Ornithology of Buenos Ayres.—Dr. J. Murie read the second part of his memoir on the anatomy of the Sea Lion (*Otaria jubata*), as observed in the male of this species which died in the Society's Gardens in 1867.—Mr. J. B. Perrin read a paper containing notes on the anatomy of the Smaller Fin-Whale *Balænoptera rostrata*), as observed on dissection of a young female specimen of this species captured at Weymouth in April, 1870.—A communication was read from Dr. G. Hartlaub and Dr. O. Finsch, containing the description of a remarkable new Finch from the Navigators' Islands, proposed to be called *Lobiospiza notabilis*.—A communication was read from the Rev. O. P. Cambridge, containing notes on a collection of *Arachnidea* made by Mr. J. Keast Lord in the Peninsula of Sinai and on the African borders of the Red Sea.—A paper was read by Mr. G. Gulliver, F.R.S., containing observations on certain points in the anatomy and economy of the Lampreys.—Dr. A. Günther read a notice of the hitherto unrecorded occurrence of *Lates calcarifer*, a fish belonging to the Perch family, in Australia.—A communication was read from Dr. J. E. Gray, containing the description of the skull of the adult *Eupleres goudoti*. This Madagascar mammal was previously only known from an immature specimen in the Paris Museum.—A second communication from Dr. Gray contained notes on *Hapalemur simus*, a new Lemur, described from a specimen lately living in the Society's Gardens. —Messrs. Sclater and Salvin communicated descriptions of five new species of birds from the United States of Columbia.—A second communication from the same authors contained an account of the collections of birds recently made by Mr. George M. Whitely on the line of the Inter-Oceanic Railway of Honduras.—Mr. Sclater read descriptions of three apparently new species of Tyrant Birds, of the genus *Elainea*, to which were added remarks on other known species of the same group.—Mr. St. George Mivart read a paper on the myology of a species of Chameleon (*Chameleon parsoni*).—Mr. Gould exhibited and pointed out the characters of two new species of Humming Birds recently collected by Mr. Buckley in Ecuador, which he proposed to call *Chætocercus bombilius* and *Thalurania hypochlora*.

Anthropological Society, December 6.—Dr. J. Beddoe, President, in the chair. Mr. W. R. Cooper exhibited and shortly described two Græco-Egyptian terra-cotta figures from the Hay Collection, showing a remarkable form of the head.—A paper was read by Mr. A. L. Lewis, "Suggestions and Reflections respecting the Peoples inhabiting the British Isles." The author divided the inhabitants of Britain into three leading types: 1st, the Kymric, long-headed, dark-haired, and light-eyed; 2nd, the Iberian, dark-haired and dark-eyed; 3rd, the Teutonic, broad-headed, light-haired, and light-eyed; the first two types being included under the collective name of Celt. After touching on some of the physical racial questions connected with the intermixture of these types, the paper concluded with some remarks tending to controvert certain popular ideas in reference to their mental characteristics, and their respective love of freedom, honesty, and chastity.

Entomological Society, Dec. 5.—Mr. A. R. Wallace, President, in the chair. Mr. Edward Saunders exhibited three new British *Hemiptera*, belonging to the genera *Salda*, *Plociomerus*, and *Hadrodema*. Mr. F. Smith exhibited *Baridius scolopaceus*, a beetle new to Britain, also *Calodera rubens*, both species captured in Kent. Mr. Butler exhibited a dark dwarf of *Vanessa urticæ*. Mr. Pascoe exhibited two new forms of *Longicornia* from the Himalayas. Mr. Albert Müller exhibited photographs of galls caused by several species of *Cynips*, sent by Mr. Bassett, of Waterburg, U.S.A. Mr. S. S. Saunders exhibited a living spider,

Eresus ctenizoides, from Syra, where it lived under stones and fed on large grasshoppers; it had remained without food since July. The paper read was "A Monograph on the *Ephemeridæ*," by the Rev. A. E. Eaton. Mr. G. H. Verrall was elected a member of the Society.

London Institution, December 1.—Prof. Morris delivered a lecture "On Gems and Precious Stones," in which the characters of the various mineral substances used in jewellery were minutely explained. The diamond, the only representative among the gems of the elementary bodies, received special attention. The lecturer referred to its crystalline form, cleavage, hardness, specific gravity, and refractive power, the characters by which it is distinguished from crystallised quartz and other minerals. He described the dull and unattractive varieties of the diamond known as "carbonado" and "boort," and pointed out their application to steel-engraving, glass-cutting, and rock-boring. The mineralogical and geological features of the diamond-beds of India, Brazil, Borneo, South Australia, and South Africa, were discussed at length, and the frequent association of diamonds with itacolumite, gold, and rutile was referred to as a subject worthy of careful investigation. Other precious stones, such as the sapphire, ruby, emerald, beryl, topaz, jargon, garnet, spinel, and turquoise, were successively treated of, reference being made to their chemical composition, their physical properties, and their application to decorative and industrial purposes. To illustrate the lecture, Messrs. Blogg and Martin contributed a unique series of uncut diamonds exhibiting perfect crystalline forms, diamonds from South Africa, and one remarkable specimen embedded in the "cascalho," taken from a bed in Brazil. Prof. Tennant also contributed a splendid collection of diamonds in the natural state. Through the kindness of Messrs. Hunt and Roskell, the lecturer was enabled to show a fine series of precious stones and models of the great South African diamond before and after cutting. To Mr. James Gregory again, the lecturer was indebted for a collection of minerals used for ornamental purposes, models of celebrated diamonds, and samples of the gravels and rocks associated with the diamonds in South Africa.

December 5.—Dr. Odling gave his sixth lecture "On Chemical Action," and illustrated his remarks on the circumstances which modify chemical action by a series of brilliant experiments, in which the oxy-hydrogen blowpipe was largely used.

Chemical Society, December 1.—Prof. Williamson, F.R.S., President, in the chair. The following gentlemen were elected Fellows:—H. E. Armstrong, Ph. D., R. Barklie, W. L. Carpenter, T. M. Crafts, Prof. of Chemistry in Cornell University, J. Dewas, T. Farries, R. Mallet, F.R.S., and Dr. Ogg. Mr. Perkin, F.R.S., read a paper "On some derivatives of Anthracene." This was a detailed account of some Anthracene derivatives, more particularly of the products resulting from the action of sulphuric acid upon dibrom and dichloranthracene. Dichloranthracene is most conveniently prepared by passing chlorine gas over benzole, holding about one-fifth its weight of purified commercial anthracene in suspension, until the mixture becomes a crystalline mass. The product is then brought on to a linen filter, drained, washed with cold benzole, dried, and then further purified by distillation and subsequent recrystallisation from benzole. Thus obtained it appears in golden yellow needles. The mean of several analyses gave 67·91 per cent. C, 3·34 per cent. H, and 28·70 per cent. Cl, which numbers agree perfectly with the formula of Graebe and Liebermann, $C_{14}H_8Cl_2$. Dichloranthracene, when greatly heated, sublimes in beautiful needles, which may be obtained of considerable size. It is fluorescent in the solid state as well as when in solution. When a boiling solution of dichloranthracene in benzole is added to a similar solution of picric acid, the mixture assumes a dark orange-red colour, and on cooling becomes filled with small bright red needles. These consist of a compound of dichloranthracene and picric acid. A determination of the dichloranthracene in this body gave numbers closely approximating to those required by the formula, $C_{14}H_8Cl_2, C_6H_3(NO_2)_3O$. Dibromanthracene. This product was prepared by Graebe's process. It was, however, purified first by distillation and then by crystallisation from benzole. Thus obtained, it is of a golden yellow colour. It gave, on analysis, numbers closely agreeing with those required by the formula

$$C_{14}\,H_8\,Br_2$$

Like dichloranthracene, this body produces a beautiful red compound with picric acid. Action of Sulphuric Acid on Dichloranthracene. Dichloranthracene, when submitted to the action of fuming sulphuric acid, dissolves, forming a bright green solution, and is at the same time converted into a sulpho-acid. To prepare this acid, one part of dichloranthracene is added to about five parts of fuming sulphuric acid, and the mixture heated for a short time in the water bath. It is then gradually poured into several times its bulk of water and treated with carbonate of barium until all the sulphuric acid is neutralised. The acid solution, when filtered off from the sulphate of barium, is evaporated to a small bulk. When sufficiently concentrated, it becomes, on cooling, a shiny mass of minute orange-yellow coloured crystals, which may be drained on a porous tile. This acid has not been analysed, but, from the composition of its salts, evidently possesses the formula

$$C_{14}\,H_6\,Cl_2\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.$$

Mr. Perkin therefore proposes to call it disulphodichloranthracenic acid. It is easily soluble in water from which it is precipitated upon the addition of a little concentrated sulphuric or hydrochloric acid. It possesses a strongly acid taste and character. The acid forms salt with sodium, barium, calcium, and strontium. The barium salt is remarkable for its insolubility in hydrochloric acid.

Dibromanthracene yields with strong sulphuric acid an analogous disulphodibromanthracenic acid,

$$C_{14}\,H_6\,Br_2\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.$$

Its sodium, barium, &c., are similar to the salts of disulphodichloranthracenic acid.

Oxidation of disulphodichloro, and disulphodibromanthracenic acid. These sulpho-acids, when subjected to the influence of oxidising agents, rapidly decompose, exchanging their chlorine or bromine for oxygen, and are thus converted into disulphanthraquinonic acid.

$$\underbrace{C_{14}\,H_6\,Cl_2\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.+O_2}_{\text{Disulphodichloranthracenic acid.}} = \underbrace{C_{14}\,H_6\,(O_2)''\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.+Cl\,Cl}_{\text{Disulphanthraquinonic acid.}}$$

$$\underbrace{C_{14}\,H_6\,Br_2\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.+O_2}_{\text{Disulphodichloranthracenic acid.}} = \underbrace{C_{14}\,H_6\,(O_2)''\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.+Br\;Br}_{\text{Disulphanthraquinonic acid.}}$$

An analogous result is also obtained by treating them with concentrated sulphuric acid, the following reactions taking place:—

$$C_{14}\,H_6\,Cl_2\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.+H_2SO_4=C_{14}H_6(O_2)''\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.+2\,HCl+SO_2$$

$$C_{14}\,H_6\,Br_2\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.+2\,H_2\,SO_4=C_{14}\,H_6\,(O_2)''\left\{\begin{matrix}HSO_3\\HSO_3\end{matrix}\right.+Br_2+2\,SO_2+2\,H_2O$$

Anthracene when pure in large crystals shows a beautiful fluorescence, and so do many of the anthracene products, though curiously their solutions are comparatively poor in this respect. Anthracene and dichloranthracene in the state of vapour are not at all fluorescent, and moreover, a ray of light sent through the length of about four inches of the vapour of either body, still retains its power of rendering fluorescent bodies luminous. The experiments in this direction are, however, not yet concluded. On sealing up anthracene in a long vacuum tube with platinum poles, and allowing the discharge from an induction coil to pass through the tube, nothing particular is observed except the beautiful fluorescence of the crystals of anthracene. On examination with the spectroscope, the light showed carbon and nitrogen lines, the latter arising from the presence of a little air in the tube. Upon heating the tube, however, somewhat strongly, so as to volatilise the hydrocarbon, the ordinary colour of the discharge changed to a magnificent deep azure blue, and what is remarkable is that this blue light, when examined with the spectroscope, is perfectly continuous, and consists of blue with a little green. Dichloranthracene, when heated in a similar manner, gives an analogous result, but suffers a good deal of decomposition, anthracene changing but little. These curious results do not appear to be due to the fluorescent character of the substances employed, as napthaline produces a similar effect, the blue light, though not so intense, being continuous. It must be observed, however, that this hydrocarbon undergoes considerable change, becoming brown and oily. Anthracene heated in a vacuum tube in the same way gives a greenish blue light, showing faint carbon bands. On exposing a solution of disulphodichloranthracenic acid to the light of one of the recent displays of the aurora borealis it was very strongly illuminated, as might be expected. Moonlight,

on the other hand, had no perceptible effect upon it, nor yet an alkaline solution of esculine. Mr. Perkin illustrated his interesting communication by a series of most beautiful experiments.

VIENNA

Imperial Academy of Sciences, October 20.—Dr. L. Manol communicated a memoir on chest and head voice, in which he described the condition of the glottis during the production of these two kinds of sounds.

November 3.—Prof. E. Stahlberger transmitted a memoir on the ebb and flow at Fiume.—Dr. Reuss presented a memoir on the Foraminifera of the Septaria clay of Pietzpuhl, containing the determination of the species figured by M. von Schlicht. Pietzpuhl possesses the richest Foraminiferous fauna of any known locality for the Septaria clay; the author has distinguished 164 species and twenty varieties, the total number found in the formation being 244 species.—Dr. C. Jelinek exhibited and explained a new anemometer, constructed for the station at Lesina, by Hipp, of Neuchatel.—Dr. T. R. von Oppolzer communicated a memoir on Winnecke's periodic comet, in which he endeavoured to show that this comet presents no extraordinary anomalies in its movement. This memoir also contained an account of the author's method of calculating disturbances.

November 10.—Prof. J. Gottlieb transmitted a chemical analysis of the Königsbrunnen at Kostreinitz, in Lower Styria, and a memoir by M. A. F. Reibenschuh, containing the analysis of the Johannesquelle, near Stainz, in Merau.—Prof. Loschmidt communicated a continuation of the results obtained by M. A. Wretschko in his researches on the diffusion of gaseous mixtures.

I. R. Geological Institute, Oct. 30.—Baron v. Richthofen, in a letter dated Pekin, July 20, gives a notice of his recent geological explorations in China. On the first of January he started from Canton and travelled through the provinces of Kwangtung and Hunan to Hankan, and then, through Hupe, Honan, and Shansi, to Peking. The most important result of this journey is the discovery of the enormous extension of coal-fields and iron-ores in the province of Shansi. The southern half of this province, about 1,500 German square miles, and probably also the northern half, is an almost continuous coalfield, containing anthracite of the best quality, in layers of from twelve to thirty feet in thickness. The anthracite district is much more extensive than that of Pennsylvania, and offers incomparably more favourable conditions for working. Together with the coal, iron ores of very good quality are found in abundance.—M. Th. Fuchs gives a sketch of different discoveries in the tertiary basin of Vienna which he made last summer, in company with M. F. Karrer. The building of the new aqueduct for Vienna has caused denudations near Baden, which prove clearly that the marine clay (Tegel) of Baden overlies the Leytha limestone. Between the Cerithium (Sarmatic) beds and the overlying Congeria beds, they discovered in many localities a thin stratum, which contains the fauna of both these formations mixed, without any sensible difference in the form or size of the various species. M. E. Tietze has explored the Jurassic and Liassic strata in the southern Banat, in the environs of Bersgasyka. He found that large masses of white and red limestones, which belong to the tithonic age, immediately cover the famous Ammonite bed, near Swinitga, which has long been known as belonging to the middle Jurassic formation. Farther down are developed different members of the lias, which contain considerable layers of coal.—M. G. Stache, during the summer, was occupied with the exploration of the central crystalline masses in eastern Tyrol, chiefly in the environs of the Ziller Valley. He brings full evidence that metamorphic stratified rocks, partly even with traces of organic remains, play a considerable part in the composition of the large mountain masses of that country.

GÖTTINGEN

Royal Academy of Sciences, October 19.—M. W. Krause read a paper on the termination of the nerves in the tongue of man; and M. P. Gordan a memoir on the partial differential equations, of which the resultant R satisfies a form of the n^t degree and a form of the m^t degree.

November 12.—M. R. Lipschitz communicated contributions to the theory of the reversal of a function system.—A paper was also read by Dr. R. von Willemoes-Suhm on a *Balanoglossus* from the North Sea. This paper contained the description of a third species of the genus discovered by the author in the Oeresund near Helleback, in Iceland. He names the worm *B. kupfferi*, and dredged it up from a depth of 12 to 16 fathoms in a bottom of fine mud.

November 16.—A paper on asymptotic lines, by M. A. Enneper, was read.

BOOKS RECEIVED

ENGLISH.—Use and Limit of the Imagination in Science: Prof. Tyndall (Longmans and Co.).—The Intelligence and Perfectibility of Animals: G. G. Le Roy (Chapman and Hall).—The Wild Garden: W. Robinson (J. Murray). Lessons in Elementary Physics: Prof. B. Stewart (Macmillan and Co.).—Chemical Problems: T. E. Thorpe (Macmillan and Co.).—The Modern Men of Letters: J. H. Friswell (Hodder and Stoughton).—One Thousand Gems: H. W. Beecher (Hodder and Stoughton).

DIARY

THURSDAY, DECEMBER 15.

ROYAL SOCIETY, at 8.30.—Report on Deep-Sea Researches carried on during the months July-September, 1870, in H.M. Surveying Ship *Porcupine* (conclusion): Dr. Carpenter, F.R.S., and J. Gwyn Jeffreys, F.R.S.—On the Constitution of the Solid Crust of the Earth: Archdeacon Pratt, F.R.S.—Actinometric Observations made at Dehra and Mussoorie, in India: Lieut. Hennessey.

SOCIETY OF ANTIQUARIES, at 8.30.—On the Pre-Christian Cross: Mr. H. M. Westropp.

LINNEAN SOCIETY, at 8.—On Sabadilla from Caracas (*Asagræa officinalis* Link.): A. Ernst.—A letter on the Californian Pitcher-plant (*Darlingtonia*); W. Robinson, F.L.S.

CHEMICAL SOCIETY, at 8.—On some New Derivatives of Coumarin: Mr. W. H. Perkin.

LONDON INSTITUTION, at 7.30.—On Count Rumford and his Philosophical Work: Mr. W. Mattieu Williams.

MONDAY, DECEMBER 19.

LONDON INSTITUTION, at 4.—On Chemical Action: Professor Odling, F.R.S.

TUESDAY, DECEMBER 20.

ANTHROPOLOGICAL SOCIETY, at 8.—Archaic Structures of Cornwall and Devon: Mr. A. L. Lewis.—Objections to the Theory of Natural Selection: Dr. Muirhead.—The Manx of the Isle of Man: Dr. Richard King.—The Anthropology of Lancashire: Dr Beddoe.

STATISTICAL SOCIETY, at 7.45.—On Wool Supply: Mr. A. Hamilton.

WEDNESDAY, DECEMBER 21.

GEOLOGICAL SOCIETY, at 8.—On the older Metamorphic Rocks and Granite of Banffshire: Mr. T. F. Jamieson.—On Lower Tertiary Deposits recently exposed at Portsmouth: Mr. C. J. A. Meyer.—On the Chalk of the Cliffs from Seaford to Eastbourne, Sussex: Mr. W. Whitaker.—On the Chalk of the Southern Part of Dorset and Devon: Mr. W. Whitaker.

SOCIETY OF ARTS, at 8.—On a Method of Lighting Towns, Factories, or Private Houses by means of Vegetable or Mineral Oils: Mr. Albert Silber.

ROYAL SOCIETY OF LITERATURE, at 8.30.—On a passage in *Othello* (by the late Rev. W. W. Berry): Dr. C. M. Ingleby, For. Sec. R.S.L.—On the Great Seals of William the Conqueror: Mr. Walter De Gray Birch.

THURSDAY, DECEMBER 22.

ROYAL, at 8.30.

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